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Rio Blanco Oil Shale Company

MODULAR DEVELOPMENT PHASE
MONITORING REPORT SIX

Volume 1 of 2

December 1979 — May 1980

Mid Year Report

Gulf Oil Corporation/Standard Oil Company (Indiana)
A General Partnership
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RIO BLANCO OIL SHALE COMPANY
MODULAR DEVELOPMENT PHASE
MONITORING REPORT 6

December 1979 - May 1980

MID-YEAR REPORT

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Prepared by:
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DENVER, COLORADO

August 29, 1980

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SECTION 1
INTRODUCTION

In 1969, the U.S. Department of the Interior initiated planning for a prototype oil shale leasing program that eventually resulted in Gulf Oil Corporation and Standard Oil Company (Indiana) acquiring an oil shale lease for Tract C-a in the Piceance Creek basin of northwest Colorado in 1974. These two companies are now operating the tract under a general partnership called the Rio Blanco Oil Shale Company (RBOSC).

Since its inception in 1974, RBOSC has been conducting extensive environmental data collection programs. Between October 1974 and September 1976, two years of baseline data were gathered. From September 1976 through August 1977, interim environmental data were collected during the period in which RBOSC had suspended tract development activities. In August 1977, RBOSC launched their Modular Development Phase (MDP) Environmental Monitoring Program. The first report of MDP environmental activities (September - November 1977) was published in February 1978. Subsequent reports were published in September 1978, March 1979, August 1979, and March 1980. The current report represents RBOSC's sixth MDP Monitoring Report, and covers the period from December 1979 - May 1980.

The RBOSC MDP Environmental Monitoring Program provides air quality, meteorology, terrestrial ecology, aquatic ecology, and hydrology data. Monitoring program designs are based on analysis of baseline and interim studies data, an assessment of probable developmental impacts, and recommendations from the Area Oil Shale Office (AOSO). The monitoring conducted during this reporting period was done according to the RBOSC MDP Environmental Monitoring Program Scope of Work, which was dated March 30, 1979 and approved by the AOSO on April 26, 1979, with 17 Conditions of Approval. This scope of work reflects the environmental monitoring philosophy set forth in RBOSC's Detailed Development Plan (DDP).

Major responsibility for monitoring program activities rest with RBOSC Environmental Affairs Department personnel. However, several consultants were used in various capacities during this reporting period. They include: Mr. J.R. Fleming (air studies data handling), NUS Corporation (water quality analyses), Wright Water Engineers (environmental hydrology), Morrison-Knudsen (operational

hydrology), MARIAH Associates (aquatic studies), USGS (surface water gaging station program). Section 4.0 - Aquatic Studies was prepared by MARIAH Associates; Section 5.0 - Hydrology Studies, which includes the USGS water data, was prepared by Wright Water Engineers. Visibility studies were carried out by Cathedral Bluff's Oil Shale Venture (Tract C-b) in a joint effort.

Data collected during MDP monitoring studies are reported semi-annually, in a mid-year and a year-end report. Monitoring Report 6, the third mid-year data report, presents the data collected for the six-month period, a summary of the winter and spring data, brief discussions of the data, comparisons of the winter and spring 1979 data with previous data where applicable, and notations on impacts which may have been caused by initial development activities, if any.

Objectives of the monitoring program are presented herein. Methods are presented only if they differ from those presented in previous RBOSC MDP Monitoring Reports, if they require clarification, or if they have not been previously reported. The "Special Studies" section discusses studies that are conducted periodically, or opportunistically, and provides a format for presenting data that might otherwise be obscured. Volume 1 of this report contains eight sections as follows:

Section 1 - Introduction
Section 2 - Atmospheric Studies
Section 3 - Terrestrial Studies
Section 4 - Aquatic Studies
Section 5 - Hydrology Studies
Section 6 - Special Studies
Section 7 - Ecological Interactions
Section 8 - Summary

Volume 2 contains the following appendices:

2-1 Air Quality Data
2-2 Meteorological Data

2-5 Visibility Data

3-1 Vegetation Data

3-2 Fauna Data

4-0 Aquatic Data

5-1 Surface Water Data

5-2 Ground Water Data

6-2 Revegetation Data

SECTION 2
ATMOSPHERIC STUDIES

The Tract C-a atmospheric studies program consists of two elements: (1) measurements of total suspended particulate matter and certain gaseous chemical compounds, and (2) measurements of selected meteorological parameters. The monitoring locations were originally established to measure the ambient air quality generally upwind and somewhat removed from the expected tract development, and at points where tract developments might have an effect on the air quality. Simultaneous meteorological measurements are being made to allow evaluations of air quality changes and for the prediction of the dispersion of emissions resulting from tract development.

Air quality and meteorological data have been obtained from monitoring instruments located on or near Tract C-a since February 1975. The first two years of data collection make up the baseline data set. Data from the baseline period were obtained at four locations around the tract. Following the baseline period, an interim data acquisition program was established to cover an interval during which the tract development lease conditions were modified and partially suspended. During the interim period (February through August 1977), a single air quality and meteorological monitoring station was operated to maintain data continuity.

The current program is part of the Modular Development Phase (MDP). The level of activity on the tract, principally construction work, has increased significantly during the MDP period. The monitoring program has been strengthened in order to measure possible effects of increased tract activity on the ambient air quality. Two of the sites that had been deactivated for the interim period were refitted with meteorological instrumentation and put back on-line during the first quarter of the MDP. In addition, one of the reactivated meteorological sites has been refitted with a complete set of air quality instrumentation (Table 2-1).

Table 2-1. Air Studies Monitoring Parameters and MDP Program Schedule, Tract C-a

Parameter	Location	Start Date	Frequency
Sulfur Dioxide	Site 1	Sept. 1977	Continuously
	Site 3	Jan. 1978	Continuously
	Site 5		Not defined yet
Nitrogen Oxides	Site 1	Sept. 1977	Continuously
	Site 3	Feb. 1980	Continuously
Nitric Oxide	Site 1	Sept. 1977	Continuously
	Site 3	Feb. 1980	Continuously
Hydrogen Sulfide	Site 1	Nov. 1977	Continuously
	Site 3	Jan. 1978	Continuously
Carbon Monoxide	Site 1	Oct. 1977	Continuously
	Site 3	Feb. 1980	Continuously
Hydrocarbons (1)	Site 1	Sept. 1977	Continuously
Ozone	Site 1	Sept. 1977	Continuously
	Site 3	Nov. 1977	Continuously
Particulates	Sites 1, 2, 3	Dec. 1977	Every 3rd day
	Site 6 1/	Dec. 1977	Every 3rd day
Wind direction (10m)	Sites 1, 2, 3	Sept. 1977	Continuously
Wind direction (60m)	Site 1	Sept. 1977	Continuously
Wind speed (10m)	Sites 1, 2, 3	Sept. 1977	Continuously
Wind speed (60m)	Site 1	Sept. 1977	Continuously
Wind sigma (10m)	Site 1	Sept. 1977	Continuously
Ambient temperature (10m)	Sites 1, 2, 3	Sept. 1977	Continuously
Temperature differential (10-60m)	Site 1	Sept. 1977	Continuously
Precipitation	Sites 1, 2, 3 & other selected locations	Oct. 1977	By event
Snow depth and accumulation	Sites 1, 2, 3	Nov. 1978	By event
Solar radiation	Site 1	Sept. 1977	Continuously
Dewpoint (10m)	Site 1	July 1978	Continuously
Visibility	Visibility Shelter	Spring 1978	Semi-annually
Noise	16 locations on tract	Jan. 1978	Quarterly

1/ discontinued by agreement with AOSS

2.1 AIR QUALITY

Air quality monitoring is being conducted on and near Tract C-a to measure the concentrations of certain pollutants which may be emitted by tract operations. The ambient air quality monitoring network consists of two locations where gaseous constituents are measured (Sites 1 and 3) and three locations where particulate concentrations are measured (Sites 1, 2, and 3). Sites 1 and 2 generally measure background ambient air quality, while Site 3 is located in a broad gulch that may have some air quality changes due to dispersion under downvalley flow from the main development area in the center of the tract.

All of the air quality data, with the exception of the particulate data, are collected on automatic monitoring equipment and recorded on digital computer tape and backup strip charts by a data acquisition system. The data on the digital tape are averaged into hourly values. High volume samplers are used to collect 24-hour samples of particulate data every third day at three sites.

A cooperative visibility study (with Tract C-b) has been conducted each Spring and Fall since 1978 as part of the air studies program. This year an addition has been made to the study by measuring the visual range with a telephotometer as well as with the traditional photometric technique. These data will allow comparisons to be made between the two measurement techniques. However, the Spring visibility study was not completed during the reporting period. The data and results will be included in the year-end report.

Starting in February, 1980, CO and NO/NO_x analyzers were re-installed at Site 3 and included in the data acquisition system. There is now a full complement of operational air quality analyzers at both Sites 1 and 3 (Table 2-2).

Air quality data taken during the tenth and eleventh quarters of the MDP program are presented in Appendices 2-1.1 (gaseous constituents) and 2-1.2 (total suspended particulates).

A. Sulfur Dioxide

1. Objectives

The objective of monitoring for sulfur dioxide is to establish the ambient air concentration prior to and during tract development. The existing sulfur dioxide levels and their associated environmental effects can be compared to future environmental changes that may be related to any increase in the concentration of sulfur dioxide.

2. Methods

The methods followed for collection of sulfur dioxide data were described in RBOSC MDP Monitoring Report 5 and are not repeated herein.

3. Results and Discussion

The new pulsed fluorescent SO_2 monitors installed at Sites 1 and 3 have proven to be excellent instruments and the data recovery has been very good. Maximum SO_2 concentrations during this reporting period were 0.014 ppm at Site 1 and 0.013 ppm at Site 3, while the mean SO_2 concentrations were 0.002 and 0.003 ppm, respectively (Table 2-2).

B. Hydrogen Sulfide

1. Objectives

The objective of monitoring hydrogen sulfide in the ambient air on the tract is to establish the background value. Tract development, which will involve recovery of sulfur-bearing organics, may release hydrogen sulfide into the ambient air. Concentrations of this constituent in the future may be compared to pre-development conditions to assess environmental impacts.

Table 2-2. Summary of Air Quality Data Collected Between December 1979 and June 1980, Tract C-a

Parameter	Units	Minimum[1/]	Maximum[1/]	Arithmetic Mean
		Site 1		
O_3	ppm	0.013	0.077	0.048
CO	ppm	0.5	0.9	0.5
NO	ppm	0.005	0.061	0.005
NO_x	ppm	0.005	0.062	0.005
H_2S	ppm	0.002	0.012	0.003
SO_2	ppm	0.002	0.014	0.002
TSP[2/]	$\mu g/m^3$	2.	36.	8.[3/]
		Site 2		
TSP[2/]	$\mu g/m^3$	1.	42.	8.[3/]
		Site 3		
O_3	ppm	0.003	0.070	0.037
NO	ppm	0.005	0.024	0.005
NO_x	ppm	0.005	0.016	0.005
H_2S	ppm	0.002	0.029	0.003
SO_2	ppm	0.002	0.013	0.003
TSP[2/]	$\mu g/m^3$	1.	51.	10.[3/]

[1/] Hourly average

[2/] 24-hour averages

[3/] Geometric Mean

2. Methods

New pulsed fluorescent H_2S analyzers were installed at Sites 1 and 3 just prior to this reporting period. These instruments have a lower threshold of detection than the instruments which they replaced. Consequently, the minimum concentrations reported during this period (0.002 ppm) are lower than earlier reporting periods (0.01 ppm).

3. Results and Discussion

After the initial shakedown period, the new monitors have proven to be reliable instruments and the data recovery has been very good. Maximum H_2S concentrations during this reporting period were 0.012 ppm at Site 1 and 0.029 ppm at Site 3, respectively, while the mean H_2S concentration at both sites was 0.003 ppm (Table 2-2).

C. Nitrogen Oxides

1. Objectives

Nitrogen oxides are monitored to establish the existing natural background levels prior to major tract development and operation. Tract operations will involve substantial combustion with the possible generation of nitrogen oxides. Reaction between nitric oxide and hydrocarbons in the presence of sunlight could result in the local production of ozone.

2. Methods

The methods followed for collection of nitrogen oxides data were described in RBOSC MDP Monitoring Report 2 and are not repeated herein.

3. Results and Discussion

The concentrations of both nitric oxide and nitrogen oxides were below the threshold of detection most of the time during the current year, so that the

mean of both these variables at Site 1 during this reporting period was at or below 0.005 ppm (Table 2-2). This was also true at Site 3. The maximum concentrations during this period at Site 1 were 0.061 ppm for NO and 0.062 ppm for NO_x, while at Site 3 the maximums were 0.024 and 0.016 ppm, respectively.

D. Carbon Monoxide

Carbon monoxide results from the incomplete oxidation of carbon during combustion.

1. Objectives

Carbon monoxide is monitored to establish the ambient air concentration of this constituent prior to and during tract development activities. Vehicular use and fuel combustion during tract development may result in the emission of carbon monoxide in the tract area.

2. Methods

The methods followed for collection of carbon monoxide data were described in RBOSC MDP Monitoring Report 2 and are not repeated herein.

3. Results and Discussion

A CO monitor was installed at Site 3 during the middle of the reporting period, but instrumentation problems prevented the monitor from becoming fully operational until just after the end of this reporting period. The mean CO concentration at Site 1 was 0.5 ppm, with a maximum concentration of 0.9 ppm (Table 2-2).

E. Ozone

1. Objectives

Ozone monitoring is conducted to establish the ambient air concentration of this constituent prior to and during tract development and operation. The potential emissions of nitrogen oxides coupled with hydrocarbons and strong sunlight may produce photochemical reactions in the future in the tract area.

2. Methods

The methods followed for collection of ozone data were described in RBOSC MDP Monitoring Report 2 and are not repeated herein.

3. Results and Discussion

Ozone data were recorded for the entire six-month period at Site 1 and Site 3. The range of ozone concentrations was 0.013 to 0.077 ppm at Site 1 and 0.003 to 0.070 ppm at Site 3, while the mean concentrations were 0.048 and 0.037 ppm, respectively (Table 2-2). The primary hourly National Ambient Air Quality Standard (NAAQS) of 0.12 ppm was not exceeded during the period at either site.

A very strong diurnal variation with a daytime maximum occurred at Site 3, with a much weaker diurnal cycle at Site 1. This pattern is similar to that found in the data of previous years (see Monitoring Report 3 and 5). Ozone concentrations at Site 3 were almost always lower than at Site 1 -- typically the Site 3 concentration would be slightly lower during the day and much lower at night.

F. Particulates

1. Objectives

The objective of atmospheric particulate monitoring is to establish the natural background concentration and the effects of construction in the modular development phase of tract operations.

2. Methods

The total suspended particulate load in the ambient air is determined by the federal reference method utilizing high volume sampling. Suspended particulate measurements were made every fourth day and all sites were placed on the same data schedule in late March 1978. After December 1, 1978, the sampling frequency

was increased to once every third day (Table 2-1). There are three sites where particulate data are taken: Sites 1 and 2, which are generally upwind of the construction area; and Site 3, which may be exposed to particulates generated on the tract access road (approximately 100 yards from Site 3) as well as particulates generated at the construction area under certain valley flow conditions. The tract access road was paved in late June of 1979. Site 3 now represents the effects of tract development on the particulate concentrations.

3. Results and Discussion

Table 2-2 presents the geometric mean, and maximum and minimum concentrations of total suspended particulates (TSP) measured at the three sites during the monitoring period. The maximum TSP concentrations during this period were 36 $\mu g/m^3$ at Site 1, 42 $\mu g/m^3$ at Site 2, and 51 $\mu g/m^3$ at Site 3, which are well below the applicable NAAQS. Generally, higher values occurred simultaneously at all stations (Appendix 2-1.2).

2.2 METEOROLOGY

Meteorological parameters are monitored to provide information on the general climate of Tract C-a and to provide a basis for estimating the potential impact of emissions that could result from tract development and operation. Three meteorological sites have been in operation during the MDP (Table 2-1). Meteorological data recorded during the reporting period are presented in Appendix 2-2.

A. Temperature and Stability

1. Objectives

Ambient air temperature provides basic information on monthly and year-to-year variability of climatic conditions at the C-a tract. The vertical temperature differential within the lowest layers of the atmosphere can be utilized to determine the stability of the atmosphere. The stability has a profound effect on the dispersion of emissions into the atmosphere that may occur as a result of tract development and operation.

2. Methods

The methods followed for collection of temperature data were described in RBOSC MDP Monitoring Report 3 and are not repeated herein.

3. Results and Discussion

Temperatures at the site had a large range during this data period, which is characteristic of continental climates. The temperature range during this six-month reporting period at the Site 1 10 m level was -15.6 to 21.2 C; at the Site 1 60 m level, -15.4 to 20.2 C; at the Site 2 10 m level -15.3 to 21.6 C; and at the Site 3 10 m level -22.9 to 24.2 C. The temperature data at Site 3 show the influence of the gulch in widening the temperature range (Appendices 2-2.1 and 2-2.2).

B. Dewpoint

1. Objectives

Dewpoint data, collected since late July 1978, are used in the evaluation of potential cooling system alternatives. The data are more directly useable than relative humidity data, which had been collected onsite for the same purposes during the baseline period and from December 1977 to late July 1978. Relative humidity can be determined from concurrent dewpoint and temperature measurements.

2. Methods

The methods followed for collection of dewpoint data were described in RBOSC MDP Monitoring Report 3 and are not repeated herein.

3. Results and Discussion

Generally, low dewpoints were recorded during this period, as expected in a semi-arid climate. Dewpoints ranged from a low of -25.0 to a high of 5.5 C (Appendix 2-2.1).

C. Wind Speed and Wind Direction

1. Objectives

The wind speed and wind direction influence atmospheric dispersion. Measurement of the frequency of occurrence of wind speed and wind direction classes can be used in interpreting air quality data.

2. Methods

The methods followed for collection of wind data were described in RBOSC MDP Monitoring Report 3 and are not repeated herein.

3. Results and Discussion

Westerly winds prevailed at Sites 1 and 2 during the period. At Site 3, there was a strong tendency for the wind to be oriented along the axis of the gulch (southwest or northeast). See Appendices 2-2.1 and 2-2.2.

D. Precipitation

1. Objectives

Precipitation is recorded to provide data on the scavenging effects of rain and snowfall on air quality. The moisture content of the ground surface is important in plant growth and revegetation efforts, and may also influence wind erosion.

2. Methods

The methods followed for collection of these data were described in RBOSC MDP Report 2 and are not repeated herein.

3. Results and Discussion

Precipitation data from the several measuring methods are included in the data appendix (Appendix 2-2.3). There are differences in the reported precipitation between the gauges installed at each site but there is good agreement among sites for a particular gauge type. Although the wedge gauges generally have better exposure, the weighing bucket gauges have better collection and retention efficiency and are therefore considered more accurate. The weighing bucket gauges at Sites 1 and 2 recorded 7.75 and 7.51 inches of precipitation, respectively, during the six-month data period. These are considered the most representative precipitation data at the site.

E. Solar Radiation

1. Objective

Solar radiation is monitored to acquire a data base useful in interpreting air quality data.

2. Methods

The methods followed for collection of solar radiation data were described in RBOSC MDP Monitoring Report 3 and are not repeated herein.

3. Results and Discussion

The majority of the days during the monitoring period were clear with high solar radiation values, typical of a high altitude site with a dry climate. Values are reported in Appendix 2-2.1.

2.3 VISIBILITY

Documentation of visibility in the Piceance Creek Basin is a cooperative study conducted by the Rio Blanco Oil Shale Company and the Cathedral Bluffs Shale Oil Venture.

1. Objectives

The objectives of this program are to document the visibility in the area of the Piceance Creek Basin and identify trends or variations in visibility which may be evident during the monitoring program. The results of this program will provide visibility data against which past and future data may be compared and with which concurrent meteorological and air quality data may be incorporated for further evaluation and consideration.

2. Methods

Two methods are being employed in the documentation of basin-wide visibility during the Spring study. A photometric method incorporates techniques identical to those utilized during the baseline study and described in RBOSC MDP Monitoring Report 1. A second method which was first used in 1979 uses a telephotometer to derive visual ranges. The results of the two methods will be compared at the end of the study. Data are being collected every sixth day along four views during the Spring season. The Fall study has not been finalized as yet.

3. Results and Discussion

The Spring visibility study was conducted during April, May and June of 1980. Since the study was not completed during the period covered by this report, the results will be presented along with the Fall visibility study in the year-end report.

2.4 NOISE

Development activities on Tract C-a will result in increased noise levels in the area. In order to assess the potential effects of these increased noise levels, it will be necessary to identify the sources of the noise and the intensity of noise levels at various distances from these sources. The RBOSC noise survey is designed to provide these data.

1. Objectives

Regulations regarding allowable noise levels have been promulgated for the safety and well being of humans. None of the existing regulations apply to effects of noise on wildlife, although some research has been conducted in this area (EPA 1971, Effects of noise on wildlife and other animals, Memphis State University). The objectives of the environmental noise program are to:

- Provide a data base on relative noise levels at various distances from sources on the tract
- Provide data for use by wildlife biologists in assessing the overall impacts of tract development on wildlife behavior and use of the study area.

2. Methods

In order to acquire the necessary noise level measurements, sound level readings are taken once each quarter at strategic monitoring sites around the mine development area. During the period of study, two noise surveys were made. Noise measurements were taken at 16 monitoring sites on February 25, and on May 22. The monitoring sites were arranged in a configuration of concentric circles at various distances from the area of mine activity out to the borders of Tract C-a, as described in Table 2-3.

One other reading was taken in close proximity to the headframe for an indication of highest noise production.

Table 2-3. Locations of Environmental Noise Monitoring Sites, Tract C-a

Site Number	Locations/Descriptions
1	Top of knoll N.E. of Hunting Camp, E. of road down to Corral Gulch
2	South side of site access road, 20 ft S.W. of "Hill" signs
3	N.E. corner of intersection of Airplane Ridge Road and tank access road
4	South side of Corral Gulch Road at fence corner slightly past power line
5	100 ft S.E. from well CE-707, on line between survey point and Headframe
6	Northwest of Well TO-2 outside of fence, 10 ft W. of survey point
7	North side of Corral Gulch Road at Well G-S 4-5 on top of road cut
8	West side of Wolf Ridge road on small knoll directly across from entrance to Well G-S 6 and trailer camp
9	North side of fenced area at Well TO-1 near entrance
10	South side of Box Elder Gulch Road at N.E. fence corners for Well AM-3
11	North side of Corral Gulch Road at turn-around area, across from U.S.G.S. stream gauging station
12	South side of road to Met. Site #1, 0.1 mile from power line crossing and S.W. corner of well G-S 1
13	North side of Wolf Ridge Road, N.E. corner of road to Well G-S 10
14	South side of Wolf Ridge Road at Tract C-a boundary line
15	East side of road, 0.15 mile north of Met. Site #2 access road
16	North of County Road 24 at intersection of Wolf Ridge Road
A	Approximately 30 ft east of main shaft Headframe

The methods followed in the collection of noise data were described in RBOSC MDP Monitoring Report 3 and are not repeated herein.

3. Results and Discussion

Sound level readings taken during the two surveys are shown in Tables 2-4 and 2-5. The highest average decibel level was 78 dBA in the February survey and 79 dBA in the May survey. Both of these readings were obtained at the monitoring site near the headframe, which is the focal point of onsite activity. Background noise levels were on the order of 22-35 dBA and were reached when readings were taken at distances greater than about one mile from mining activities. These same general decibel levels were found in readings taken on site boundaries. Exceptions to background noise were noted when there was aircraft passing overhead, vehicular traffic in the area or some other activity (e.g. drilling) near the monitoring site.

Noise levels taken during these two surveys were generally comparable to those taken during the earlier noise surveys. The potential for wildlife disturbances due to noise of this magnitude is anticipated to be small.

Table 2-4. Environmental Sound Level Measurements Tract C-a, February 25, 1980

Site	Time	Wind	Sound Level Measurements (dBA, Slow Response) (20 sec range) 1	2	3	4	5	Sound Level dBA Range	Sound Level dBA Average	Remarks
A	8:36	Calm	74-75	74-74	72-73	72-74	73-74	72-75	74	Job noise
1	8:45	3-5/E	33-34	33-35	33-35	34-35	33-34	33-35	34	Job noise/photographer
2	11:43	0-4/var.	31-37	30-33	31-37	31-34	31-33	30-37	33	Job noise
3	11:34	0-2/var.	38-41	39-41	40-41	37-42	37-40	37-42	40	Job noise
4	9:22	3-5/SE	33-35	35-36	35-37	34-36	34-36	33-37	35	Job noise
5	9:42	0-6/SE	23-24	25-34	30-36	26-31	25-30	23-36	28	Jet airplane/job noise
6	9:54	0-7/SE	26-34	24-29	23-26	24-34	24-33	23-34	28	Job noise/assorted birds
7	10:05	0-5/SE	33-39	34-40	31-35	33-36	32-40	31-40	35	Job noise/car on highway
8	10:35	0-6/SE	24-26	24-26	24-30	24-28	24-32	24-32	26	Pickup truck in distance
9	10:24	0-8/E	31-35	31-40	30-40	24-36	24-30	24-40	32	Large truck in distance
10	Readings unattainable due to road obstruction									
11	9:15	3-5/SE	21-22	21-23	21-27	21-26	26-32	21-32	24	A Magpie gave the highest reading
12	9:34	Calm	21-22	21-22	21-24	21-22	21-21	21-24	22	No discernable noise
13	10:46	0-5/E	22-24	21-26	21-24	20-22	22-39	20-39	24	Jet airplane
14	10:56	0-9/E	29-49	25-38	25-35	22-31	21-39	21-49	31	Hydrology monitoring activities/wind
15	11:06	0-2/S	21-25	21-22	21-22	21-22	21-22	21-25	22	No discernable noise
16	10:12	0-5/SE	31-35	30-35	31-39	34-44	36-60+	30-60+	38	Vehicles/job noise (highest reading estimated)
A	11:51	0-2/var.	77-78	77-80	78-79	77-77	77-77	77-80	78	Job noise

Table 2-5. Environmental Sound Level Measurements Tract C-a, May 22, 1980

Site	Time	Wind	Sound Level Measurements (dBA, Slow Response) (20 sec range) 1	2	3	4	5	Sound Level dBA Range	Sound Level dBA Average	Remarks
A	9:11	0-3/NW	76-77	77-79	78-89	77-78	77-79	76-89	79	Job noise/heavy equipment
1	9:24	0-2/N	42-47	43-51	46-51	38-50	37-45	37-51	45	Job noise (bulldozer in and out of range)
2	12:44	3-6/W	41-47	41-47	47-72	37-40	36-40	36-72	45	Truck went by/job noise
3	13:56	8-12/SW	41-48	39-42	38-43	38-46	38-49	38-49	42	Windy/job noise
4	10:32	0-5/SW	34-38	35-40	34-41	40-46	36-45	34-46	39	Job noise
5	10:03	0-1/S	31-33	31-33	31-33	31-34	33-36	31-36	33	Job noise
6	10:20	0-2/S	32-37	31-37	31-34	30-32	30-35	30-37	33	Birds singing
7	10:57	6-12/SW	37-50	38-43	41-46	39-47	41-47	37-50	43	Windy/job noise
8	11:16	8-12/SW	37-41	42-51	60-67	40-60	36-56	36-67	49	Windy/front end loader went by
9	12:15	0-5/S	33-41	41-43	38-45	40-47	34-41	33-47	40	Windy/birds singing/jet
10	12:26	6-10/SW	36-41	32-46	38-42	38-42	34-39	32-46	39	Windy/birds singing
11	10:41	5-10/SW	41-60	40-55	37-44	35-37	35-40	35-60	42	Windy/Sun Gas drilling truck went by
12	9:55	0-3/S	31-37	30-37	32-39	28-33	27-33	27-39	33	Jet went by/birds singing
13	11:31	0-10/S	35-48	35-46	31-42	30-43	27-33	27-48	37	Windy/birds singing
14	11:40	1-8/S	30-42	32-43	32-43	31-45	31-44	30-45	37	Windy
15	11:53	1-10/S	35-40	32-40	28-31	32-36	30-38	28-40	34	Hi-Vol running at Met. Site #2/jet flew over
16	11:07	8-12/SW	42-48	42-50	52-64	35-38	37-45	35-64	45	Windy/truck went by/ job noise
A	13:14	10-20/S	74-77	72-74	72-75	72-75	73-76	72-77	74	Windy/job noise

2.5 SUMMARY AND CONCLUSIONS

Air quality and meteorological data were collected during the six-month reporting period. No unusual events or violations of National Ambient Air Quality Standards occurred. All of the air quality parameters were below the threshold of detection most of the time, with the exception of ozone and particulates. Ozone concentrations ranged from 0.013 to 0.077 ppm at Site 1, and from 0.003 to 0.070 ppm at Site 3. Particulate concentrations ranged from 1 to 42 $\mu g/m^3$ at the two sites measuring the ambient particulate levels (Sites 1 and 2) and from 1 to 51 $\mu g/m^3$ at the site located in Corral Gulch (Site 3), which is often downwind of tract activities. These values are similar to those found in earlier mid-year reports (MDP Monitoring Reports 2 and 4).

No significant changes have been detected in the meteorological data collected during the six-month data period.

A Spring visibility study using both the traditional photometric method and a telephotometer to measure visual range has been initiated but was not completed during this reporting period. The results of the Spring study will be reported in the year-end report, along with the results of the Fall study.

Two noise surveys were taken during the reporting period. During the February survey, sound level averages on the tract ranged from 22 to 40 dBA, except near the main construction area (adjacent to headframe), which averaged 76 dBA. During the May survey, sound level averages ranged from 33 to 49 dBA, except for an average of 77 dBA near the main construction area.

SECTION 3
TERRESTRIAL STUDIES

The Terrestrial Studies MDP Monitoring Program is designed to detect and evaluate the impacts affecting the vegetation or faunal components of the terrestrial ecosystems on or near Tract C-a.

The Tract C-a terrestrial studies are geared to seasonal cycles of the ecosystem components. Therefore, sampling is conducted during the seasons when activity is greatest (Table 3-1). The study period reported herein is December 1979 through May 1980. Several terrestrial programs had not been initiated or had been initiated but not completed at the end of the reporting period. Results of these programs, including color infrared (CIR) photography, phytosociology, range productivity and utilization, avifauna, and small mammal studies will be reported in the MDP year-end report. Opportunistic observations of important events and unscheduled special studies will be reported in MDP monitoring reports as they occur.

The design of the terrestrial monitoring program is based on an assessment of current knowledge of MDP mining operations. Because this is a prototype operation, new information may become available which requires a modification of the outlined program. Therefore, this monitoring program should be viewed as a flexible one which may change as engineering design is refined and as additional ecological data are obtained.

Table 3-1. Terrestrial Studies Monitoring Schedule

Parameter	Location[1/]	Start Date	Frequency
Vegetation Mapping	Tract C-a & 5-mile Perimeter	August 1978[2/]	Every 3rd year
Vegetation Stress	Anticipated impact areas	June-July 1979	Annually
Vegetation Phytosociological Studies	See Map 2	May-June 1979	Once/3-yr period Rotation Basis
Range Productivity & Utilization	See Map 2	April 1978 (establish plots)	Annually (in Sept.)
Browse Condition & Utilization	See Map 2	May 1978	Annually
Small Mammals	See Map 2	May-June 1979	Annually
Avifauna Studies	See Map 2	May-June 1979	Annually
Mule Deer Density Studies	See Map 2	Sept. 1977	Annually
Mule Deer - Road Kill Studies	County Road 24	Feb. 1979	Daily During Peak Migrations
Feral Horse Abundance	Tract C-a & 3-mile Perimeter	Jan. 1978	Annually

[1/] Locations of sampling sites were presented in RBOSC MDP Monitoring Report 5

[2/] 1978 aerial photography was accomplished in August; however subsequent flights will be scheduled for June-July.

3.1 RANGE AND BROWSE

A. Range

1. Objectives

Modular Development Phase activities on Tract C-a may affect range conditions on and near the tract by altering use patterns of deer, cattle, and feral horse populations resulting in increased grazing pressure on some portions of Tract C-a. The range studies are designed to provide information on vegetative production which can be used to compare range productivity before and during MDP activities. Because activities are confined primarily to the mine process area, impacts on range conditions are projected to be localized. Therefore, range studies focus on areas of Tract C-a that are adjacent to MDP activities and were previously used for grazing.

2. Methods

The methods followed for collection of range data were described in RBOSC MDP Monitoring Reports 1, 2, and 3 and are not repeated herein.

Range cage positions were established between April 29 and May 16, 1980. Cages were placed five meters to the right of transect location stakes (as sighted along a line from plot 1 toward plot 10).

Transect PJ 18 was disturbed by construction activities during the reporting period. An additional transect, PJ 40, was established in the same area and will replace PJ 18. Although vegetation is expected to be similar on the two transects, plot locations differ. Consequently, 1980 data for PJ 40 will not be directly comparable with that collected for PJ 18 from 1977 through 1979.

3. Results and Discussion

Sampling for production and utilization will be conducted in September and results will be reported in the year-end report.

B. Browse

1. Objectives

Tract C-a development may reduce browse availability and therefore affect animal distribution in the vicinity of Tract C-a. The browse condition and utilization studies are designed to provide browse use information for areas adjacent to Tract C-a development.

2. Methods

The methods followed for collection of browse data were described in RBOSC MDP Monitoring Reports 1 and 2. Locations of sample transects are the same as those for range productivity studies, with transect PJ 40 replacing PJ 18. Browse condition was assessed between April 29 and May 16, 1980.

3. Results and Discussion

Data obtained during the 1980 sampling period (Appendix 3-1.1) are summarized in Table 3-2.

a. Mixed Brush - All individual shrubs assessed for browse condition and utilization during 1979 were relocated and sampled again during spring 1980. Mountain mahogany (Cercocarpus montanus) was most heavily utilized (21.2% average based on 13 living individuals) whereas snowberry (Symphoricarpos oreophilus) was least heavily utilized (0.6% average for 39 living shrubs) (Table 3-2). Browse use of serviceberry (Amelanchier utahensis), the most prominent species encountered on mixed brush transects, was 3.3 percent during 1980 (based on 115 individuals). Sagebrush (Artemisia tridentata) and pinyon pine (Pinus edulis) had respective use values of 5.2 and 5.8 percent (based on 55 and 6 living individuals, respectively).

These data indicate that browse use decreased from 1979 to 1980 for serviceberry, snowberry, mountain mahogany, and pinyon pine. However, sagebrush utilization increased slightly from 5.0 in 1979 to 5.2 percent during 1980.

Table 3-2. Condition of Important Browse Species in Three Vegetation Types During April-May 1980 in the Vicinity of RBOSC Oil Shale Tract C-a[1/]

Habitat[2/] Type	Species	Number of Plants Sampled	Ave. Util. (%)	Ave. Avail. (%)	Form Class (%)[3/]								Age Class (%)				Hedging Class (%)		
					1	2	3	4	5	6	7	8	Seedling	Young	Mature	Decadent	Light	Moderate	Severe
MB	Serviceberry	128	3.3	77.7	32	12	7	16	16	7	..	10	1	5	51	44	50	34	17
	Sagebrush	61	5.2	81.4	30	21	..	11	21	7	..	10	..	..	66	34	44	49	7
	Snowberry	41	0.6	70.0	37	5	2	24	20	5	2	5	2	12	37	49	69	26	5
	Mountain Mahogany	14	21.2	85.0	14	36	14	7	7	14	..	7	14	..	57	29	23	46	31
	Pinyon Pine	6	5.8	88.3	50	33	..	17	..	..	..	..	..	..	83	17	67	33	..
PJ	Sagebrush	105	8.8	71.1	17	10	5	14	20	21	..	..	1	..	46	53	34	38	28
	Pinyon Pine	51	4.5	53.1	27	4	4	33	12	..	14	6	4	6	80	10	71	25	4
	Juniper	47	0.1	36.1	21	..	..	40	9	2	15	13	..	2	79	19	85	12	2
	Bitterbrush	23	34.5	68.3	4	17	13	4	26	26	..	9	..	..	43	57	10	48	43
	Mountain Mahogany	17	40.6	69.7	..	..	12	..	6	82	..	..	..	..	65	35	..	..	100
	Snowberry	4	1.7	73.3	..	25	50	..	..	..	..	25	..	..	50	50	33	..	67
	Serviceberry	3	1.7	33.3	..	33	..	33	..	33	..	..	..	..	33	67	33	..	67
SB	Sagebrush	235	1.1	75.3	13	13	3	15	16	13	..	26	..	..	46	54	38	45	17
	Serviceberry	10	0.6	95.6	60	20	..	10	..	..	..	10	..	30	60	10	89	11	..
	Snowberry	4	0.0	50.0	..	25	..	..	75	..	..	..	..	..	25	75	..	100	..
	Pinyon Pine	1	0.0	100.0	100	..	..	..	..	..	..	..	..	..	100	..	100	..	..

1/ .. indicate no individuals present in this category

2/ MB = Mixed Brush
PJ = Pinyon-Juniper
SB = Sagebrush

3/ Form Classes

1 All available, little or no hedging
2 All available, moderately hedged
3 All available, severely hedged
4 Partially available, little or no hedging
5 Partially available, moderately hedged
6 Partially available, severely hedged
7 Unavailable
8 Dead

The weighted average utilization for all species within the mixed brush habitat was four percent, or half that experienced in 1979 (Table 3-3). Much of this reduction seems to be related to lower use of serviceberry (3.3% in 1980 vs. 9.0% in 1979). With reduced useage in 1980 all of the species sampled in the mixed brush habitat have "acceptable" use rates for "mild" winter conditions (Cole 1963). During the 1979 season use was judged "acceptable" for "average" winter conditions.

Table 3-3. Comparison of Weighted Average Utilization (in percent) in Three Vegetation Types During April 1976, May 1977, May 1978, May 1979, and May 1980 on and Near Tract C-a[1/]

Vegetation Type	April 1976	April 1977	May 1978	May 1979	May 1980
Mixed Brush	12	17	7	8	4
Pinyon-Juniper	27	24	31	15	10
Upland Sagebrush		6	25	4	1

[1/] N = 250

Distribution of individual shrubs by form class varied only slightly from 1979 data (Table 3-2). Seven mountain mahogany plants which appeared to have died in 1979 had resprouted this year. Two serviceberry shrubs died between sample periods.

Based on age class distribution (Table 3-2) the mixed brush range condition rating would be "good" for pinyon pine, "fair" for mountain mahogany, and "poor" for serviceberry, snowberry, and sagebrush (Cole 1963). Similar condition ratings based on hedging class indicate that pinyon pine, sagebrush, and snowberry are in "excellent" condition, serviceberry "good", and mountain mahogany "poor". These ratings are similar to those evidenced during 1979.

b. Pinyon-Juniper - Variations in the number of individuals of each species sampled for the pinyon-juniper habitat between 1979 and 1980 are a

result of the replacement of transect PJ 18 with PJ 40. Use of transect PJ 40 resulted in a gain of two sagebrush, one pinyon pine, and ten juniper and a reduction of 13 bitterbrush shrubs. The total number of shrubs sampled within the pinyon-juniper vegetation type is still 250.

Browse utilization in the pinyon-juniper vegetation type ranged from 0.1 percent for juniper (Juniperus osteosperma) (35 trees available for browse) to 40.6 percent for mountain mahogany (17 living shrubs) (Table 3-2). Sagebrush remained the most abundant species encountered and had an average utilization of 8.8 percent on the 92 living individual shrubs which were assessed. Other species present included bitterbrush (Purshia tridentata) with 34.5, pinyon pine 4.5, snowberry 1.7, and serviceberry with 1.7 percent utilization. Respective numbers of available shrubs for these species were 21, 43, 3, and 3.

Average weighted utilization for all species of the pinyon-juniper vegetation type was 10 percent in 1980 as compared to 15 percent during 1979 (Table 3-3). As with the mixed brush habitat, this is the lowest use recorded since the studies began in 1976. Sagebrush utilization decreased from 11.7 in 1979 to 8.8 in 1980. Decreases also were evident for the less abundant pine, mountain mahogany, snowberry, and serviceberry individuals. Use of juniper remained unchanged, whereas bitterbrush utilization increased from 23.1 in 1979 to 34.5 percent in 1980. Browse use for all species of the pinyon-juniper habitat would be deemed "acceptable" for "mild" to "average" winter conditions (Cole 1963).

A large number of sagebrush, bitterbrush, mountain mahogany, snowberry, and serviceberry individuals were categorized as being in the decadent age class (Table 3-2). Based on the age class criterion, the aforementioned species have range condition ratings of "poor" to "very poor" (Cole 1963). Pinyon pine and juniper have respective ratings of "excellent" and "good". Similar ratings were evident for most species when using hedging classification as the controlling factor. However, in this case sagebrush would be rated in "fair" condition while pine and juniper would both have "excellent" condition ratings. These ratings for the 1980 sample period show no major change from ratings evidenced during 1978 or 1979.

c. Sagebrush - All but one individual shrub on the sagebrush transects were relocated and sampled during 1980. Plant number 25 on transect SB 22 could not be found and was replaced by the nearest appropriate individual. Consequently, one pinyon pine was added and one serviceberry deleted.

Utilization for the 173 living sagebrush plants assessed in the sagebrush vegetation type averaged 1.1 percent. Serviceberry was the only other species which received browse use (0.6 percent for nine individuals) (Table 3-2). Respective browse use of these species during 1979 was 3.9 and 3.3 percent. On the basis of weighted averages, 1980 use was only 25 percent of that noted in 1979 (Table 3-3). This decreased use follows a similar phenomenon noted for both the pinyon-juniper and mixed brush types. Lower browse use may reflect overall reductions in mule deer herd size, due to mortality during the 1979 winter season.

Fifty-four percent of the sagebrush plants censused was categorized in the decadent age class, resulting in a "very poor" range condition rating for that species. The rating for snowberry was also "very poor". Only 10 percent of the serviceberry shrubs was classified as decadent, consequently Amelanchier received an "excellent" rating based on age class determinations (Cole 1963).

Sagebrush was the only species within this vegetation type with severely hedged individuals, and the condition rating for sagebrush was "good" based on Cole's (1963) rating scheme. Range condition in the sagebrush vegetation type seems to have improved slightly from the 1979 status when condition was judged to be fair for both sagebrush and serviceberry.

3.2 FAUNA

A. Small Mammal Studies

1. Objectives

Intensive reviews of baseline data indicate that reliable small mammal population data such as density, age structure, and species diversity are difficult and costly to obtain. Given reliable data, there is little agreement in the literature about the interpretation of even gross changes in population parameters (Snyder 1978). The RBOSC small mammal program is designed to determine species presence and habitat affinity and to provide indices of relative abundance in important control and treatment habitats. The objectives of the small mammal program are to determine the presence and relative abundance (captures/ 100 trap nights) of small mammals in sagebrush and pinyon-juniper habitats in control and treatment areas, and to compare any changes in time within the habitats within the areas.

2. Methods

The methods followed for the collection of these data were described in RBOSC MDP Monitoring Report 5 and are not repeated herein.

3. Results and Discussion

The data collection period for small mammal studies is scheduled for June 1980. Results of those studies will be discussed in the year-end report.

B. Avifauna Studies

1. Objectives

There is little, if any, evidence that avifauna sampling programs that are conducted within reasonable constraints of time and money can detect anything except gross changes in bird population parameters or any of many possible

natural abiotic or biotic causes (Wiens 1977). The RBOSC avifauna program is designed to determine species composition and relative abundance in important control and treatment habitats (same habitats as monitored for small mammals).

The objectives of the avifauna program are to determine species composition and relative abundance of birds in pinyon-juniper and sagebrush habitats in control and treatment areas, and to compare any changes in time within the habitats within the areas.

2. Methods

The methods followed for the collection of these data were described in RBOSC MDP Monitoring Report 5 and are not repeated herein.

3. Results and Discussion

The data collection period for avifauna studies is scheduled for June 1980. Results of those studies will be discussed in the year-end report.

C. Mule Deer Density

1. Objective

Mule deer are the most important game species in Colorado in terms of recreational use and money expended by hunters. The Piceance Creek Basin mule deer herd is one of the largest migratory mule deer herds in North America. Tract C-a is within the Piceance Creek Basin and Colorado Division of Wildlife's (CDOW) Game Management Unit 22.

Moderate numbers of mule deer occur on Tract C-a during fall and spring migration periods and during mild winters; at other times mule deer are relatively uncommon on the tract. Consideration of the possible effects of Tract C-a oil shale development on mule deer is an integral part of RBOSC's Fish and Wildlife Management Plan.

The objectives of RBOSC's mule deer monitoring program are to obtain an index of mule deer density in a 9 x 9 mile (81 sq mile) study area centered on Tract C-a, to compare indices of mule deer density from the study area with those from the Game Management Unit 22, and, if possible, to compare differences in mule deer densities within various portions of the study area.

2. Methods

The methods followed for the collection of these data were described in RBOSC MDP Monitoring Report 1 and are not repeated herein.

3. Results and Discussion

Mule deer pellet groups were counted during May 1980 in established plots in the 63 quarter section (160 acre) sample units comprising the Tract C-a study area. Pellet group information from this sample period (Appendix 3-2.1) is summarized in Table 3-4. Detailed analyses of that information will be reported in the 1980 year-end report.

Based on Spring 1980 data (Table 3-4), it appears that the deer use of the area around Tract C-a during the 1979-80 winter was lower than that reported for the two previous winters. The average number of deer per acre was 24.9. The winter of 1979-80 was relatively mild, and the resultant shallow snow pack should have enabled the migrating deer to remain at elevations represented by the tract throughout much of the period. Therefore, reduced use of the area last winter probably represents a reduction in number of deer using the area rather than a shorter period of use. The severe 1978-79 winter resulted in high deer mortality in much of western Colorado. The limited deer use of the Tract C-a study area was probably a result of that mortality.

D. Mule Deer Road Kill Study

The Piceance Creek Basin is currently the center of a great deal of energy development activity including oil shale and natural gas. This increased activity has resulted in increased traffic flows across mule deer migration

Table 3-4. Mule Deer Pellet Groups Counted on RBOSC Tract C-a Study Area, Spring 1980

Block and Sample Unit	Number of Pellet Groups in Sample Unit	Total Number of Pellet Groups in Block	Average Number of Groups Per Sample Unit For Each Block	Average Number of Deer Per Square Mile For Each Block[1/]
1-05	4			
1-11	14			
1-16	3			
1-20	3			
1-23	6			
1-26	4			
1-31	2	36	5.14	28.5
2-05	3			
2-06	5			
2-15	8			
2-17	2			
2-24	0			
2-28	5			
2-34	10	33	4.71	26.1
3-01	2			
3-11	3			
3-14	8			
3-17	0			
3-18	3			
3-19	4			
3-34	5	25	3.57	19.8
4-01	13			
4-08	4			
4-13	1			
4-14	7			
4-18	2			
4-23	3			
4-25	1	31	4.43	24.5

Table 3-4 (Continued)

Block and Sample Unit	Number of Pellet Groups in Sample Unit	Total Number of Pellet Groups in Block	Average Number of Groups Per Sample Unit For Each Block	Average Number of Deer Per Square Mile For Each Block[1/]
5-08	14			
5-13	10			
5-15	15			
5-27	4			
5-28	4			
5-29	7			
5-36	0	54	7.71	42.8
6-08	19			
6-11	11			
6-14	13			
6-27	6			
6-30	0			
6-32	2			
6-35	3	54	7.71	42.8
7-16	3			
7-17	2			
7-19	3			
7-22	1			
7-28	1			
7-32	0			
7-34	2	12	1.71	9.5
8-03	4			
8-05	5			
8-11	0			
8-13	10			
8-14	2			
8-27	0			
8-34	2	23	3.29	18.2

Table 3-4 (Continued)

Block and Sample Unit	Number of Pellet Groups in Sample Unit	Total Number of Pellet Groups in Block	Average Number of Groups Per Sample Unit For Each Block	Average Number of Deer Per Square Mile For Each Block[1/]
9-03	0			
9-07	5			
9-09	0			
9-15	3			
9-21	5			
9-30	2			
9-35	0	15	2.14	11.9

[1/] Assuming 180 days in the winter sampling period, presence of deer throughout the period, and 13 pellet groups per deer per day. More detailed analyses per plot are being conducted and will be reported in the year-end report.

routes. The CDOW is interested in obtaining data relative to the mortality of mule deer as a result of deer-vehicle collisions.

1. Objective

The objective of this program is to provide data on mule deer mortality along County Road 24 from Piceance Creek to Tract C-a for compilation and use by the CDOW.

2. Methods

The methods followed for the collection of these data were described in RBOSC MDP Monitoring Report 5 and are not repeated herein.

3. Results and Discussion

Locations of the 11 deer killed by collisions with vehicles along County Road 24 during the reporting period are shown on Figure 3-1. Most of the collisions occurred in areas of heavy deer travel between bedding and feeding areas. Those sections of County Road 24 with a history of numerous deer kills will be posted with caution signs during future migration periods.

E. Feral Horse Abundance

1. Objectives

Feral horses occur on and in the vicinity of Tract C-a. These horses are protected under federal law and are under the jurisdiction of the BLM. Feral horses compete with cattle and, to a lesser extent, with wildlife for food and water. The objective of feral horse monitoring studies is to provide qualitative information concerning the status of feral horses in the RBOSC study area (i.e., same area as for mule deer).

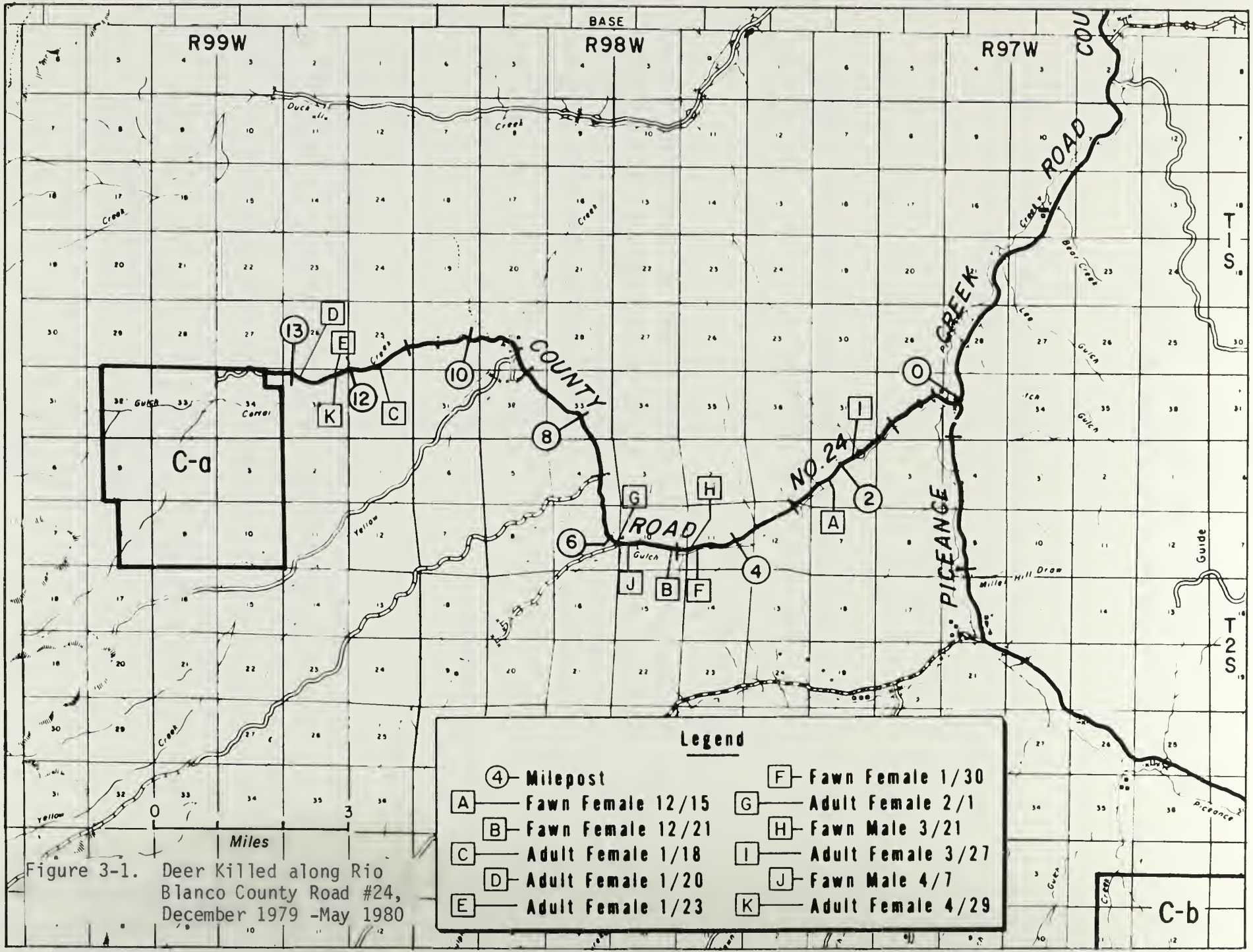

Figure 3-1. Deer Killed along Rio Blanco County Road #24, December 1979 -May 1980

2. Methods

The methods followed for the collection of these data were described in RBOSC MDP Monitoring Report 1 and are not repeated herein.

3. Results and Discussion

Feral horses on the Tract C-a study area were counted from a helicopter in January 1980. Twenty-four bands of horses totaling 120 individuals were observed in the study area (Figure 3-2). Ninety-nine horses were observed during the January 1979 count. Other feral horse observations and estimated foal success will be reported in the 1980 year-end report.

F. Threatened, Endangered and Protected Species

Baseline and monitoring studies indicate that Tract C-a does not provide critical habitat for any state or federally endangered wildlife species. No endangered species have been observed on or near Tract C-a during the reporting period nor in recent studies.

A pair of golden eagles, protected in Colorado, nested near milepost 2 above Rio Blanco County Road 24. One eaglet was observed in that nest in early April. During that period sudden thunderstorms were frequent. In mid April, the eaglet was found dead in the nest apparently from exposure to rain and cold temperatures. The parents left the area shortly thereafter.

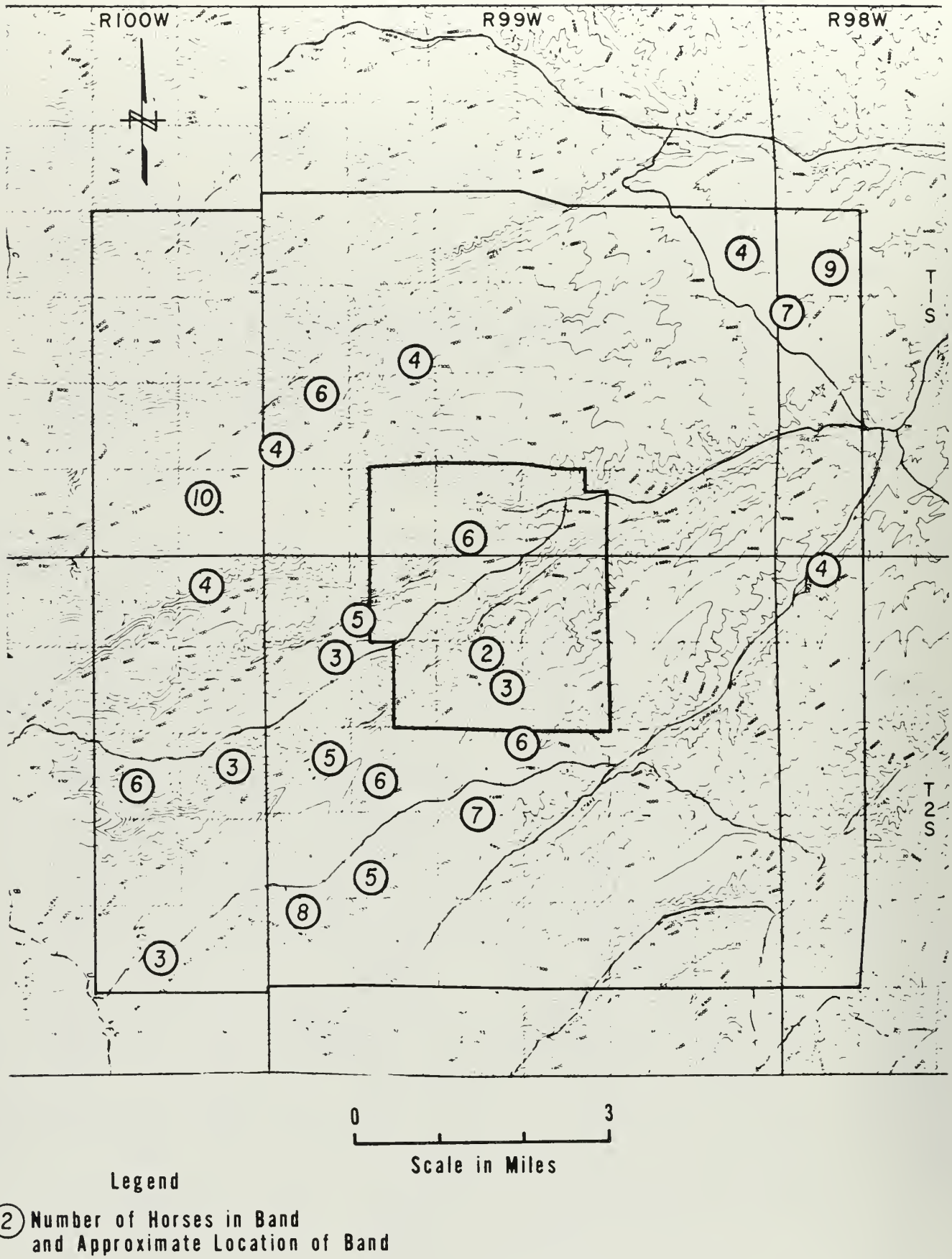

Figure 3-2. Feral Horses Observed During the January 1980 Aerial Census

3.3 SUMMARY AND CONCLUSIONS

The components of the MDP Terrestrial Monitoring Program examined during the reporting period were browse condition and utilization, mule deer density, mule deer road kills, and feral horse abundance.

Browse studies indicate that the weighted average percent utilization ranged from 1 percent in the upland sagebrush to 10 percent in the pinyon-juniper vegetation type. Utilization in all vegetation types decreased relative to 1979 data and is the lowest recorded in five years of study. Lower use in 1980 relative to 1979 may be due to decreases in mule deer herd sizes between the two years. The smaller mule deer population combined with the relatively harsh 1978-79 winter season have resulted in the continued decline in browse use since May 1978.

Range condition ratings based on age class and/or hedging class were similar to those evidenced during 1979; however, there is some indication that range condition is improving. Improvements are evident primarily in ratings based on hedging classification, and are probably due to lower browse utilization. Because the RBOSC browse studies are designed to census the same individuals on a yearly basis, one would not expect to find large changes in range condition ratings based on age classification.

The average number of mule deer per square mile using the Tract C-a study area during the winter of 1979-80 24.9, was approximately 65 percent of the number using that area during the 1978-79 winter. This reduction in mule deer density is probably a result of the extensive winter kill during 1978-79.

The number of mule deer killed by vehicle collisions along Rio Blanco County Road 24 during the reporting period was 11. Nine deer killed by collisions with vehicles were found there during the same period the year previous. The paving of the county road during the interim and increased traffic may account for the additional deer kill.

A total of 120 feral horses in 24 bands was counted in the study area during the winter aerial The count was up from 99 horses observed during the 1979 aerial survey.

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SECTION 4
AQUATIC STUDIES

The MDP Aquatic Monitoring Program is designed to provide information on aquatic ecosystems in the vicinity of Tract C-a appropriate to identifying and measuring the potential effects of modular development on local aquatic biota. The program was devised following a complete evaluation of data obtained during the RBOSC baseline studies and a determination of the possible impacts of project activities. Criteria for selecting the aquatic parameters to be measured included ecological importance, sensitivity to environmental change, and ease of sampling. Table 4-1 lists the sampling frequency and the parameters measured at each location.

Six sampling sites are used in the MDP monitoring program (Figure 4-1):

- Station 13 (springbrook habitat) at the USGS gaging station in Corral Gulch (east)
- Station 14 (pond habitat) in Corral Gulch (east)
- Station 20 (springbrook habitat) at the USGS gaging station on Yellow Creek
- Station 21 (springbrook habitat) on Yellow Creek below the USGS gaging station
- Stations 27 and 29 (White River back channel habitats) near the confluence of Yellow Creek with the White River

Sampling was initiated in October 1977. This report provides the sampling results from April and May 1980. A brief comparison with the April and May samples from previous years as well as a discussion of trends and findings are presented. Detailed evaluations of 1980 aquatic monitoring data will be included in the year-end report.

Table 4-1. Aquatic Studies Monitoring Schedule

Parameter	Location	Frequency
Abiotic Components		
Physical Measurements		
Stream Velocity		
Turbidity		
Dissolved Oxygen	Stations 13, 14, 20, 21, 27, 29 (See Figure 4-1)	6 times/year (Apr., May, June, July, Aug., Oct.)
pH		
Specific Conductance		
Depth		
Width		
Stream Substrate		
Water Quality Measurements (White River)		
Boron		
Calcium		
Chloride		
Fluoride		
Magnesium	Stations 27, 29 (See Figure 4-1)	6 times/year (Apr., May, June, July, Aug., Oct.)
Nitrate		
Orthophosphate		
Potassium		
Total Phosphate		
Silica		
Sulfate		
Sodium		
Alkalinity		
Total Dissolved Solids		
Bicarbonate		

Table 4-1. (Continued)

Parameter	Location	Frequency
Biotic Components		
Periphyton		
Species Composition Relative Abundance Biomass Diversity	Stations 13, 14, 20, 21 27, 29 (See Figure 4-1)	6 times/year (Apr., May, June, July, Aug., Oct.)
Benthos		
Species Composition Relative Abundance Diversity	Stations 13, 14, 20, 21 27, 29 (See Figure 4-1)	6 times/year (Apr., May, June, July, Aug., Oct.)

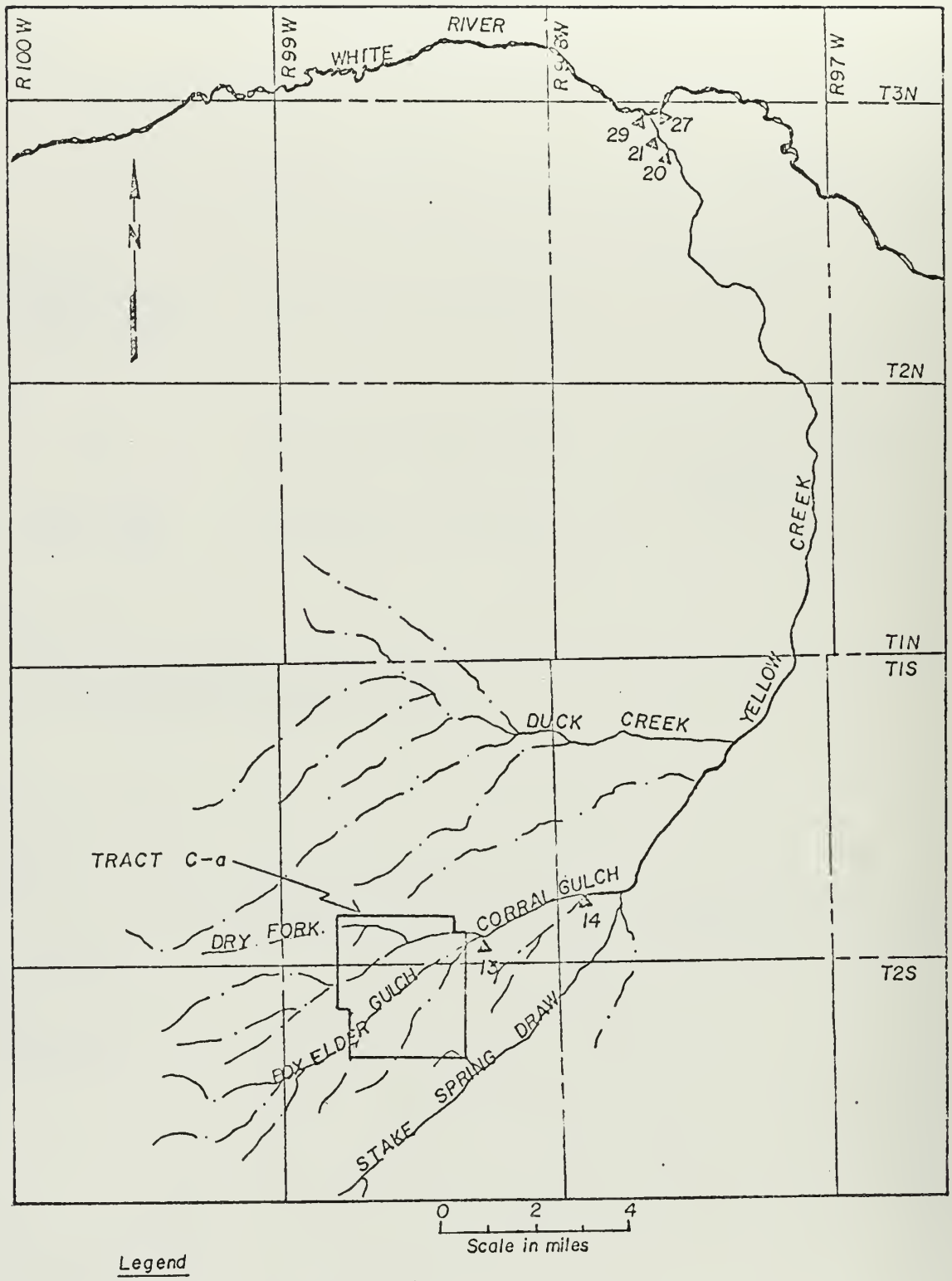

Figure 4-1. Locations of Aquatic Sampling Sites, RBOSC, Tract C-a

4.1 ABIOTIC COMPONENTS

A. Physical Measurements

1. Objectives

The physical measurement program is designed to monitor selected physical parameters at MDP aquatic sampling stations and relate these data to water quality and aquatic biota conditions. The parameters selected for monitoring are those which may be indicative of effects related to project activities and which have been found to be particularly significant to the important aquatic organisms observed during baseline studies. Chemical parameters, such as dissolved oxygen, which were recorded in conjunction with the physical measurements are also presented and discussed in this section.

2. Methods

Methods used to collect physical stream data were described in RBOSC MDP Monitoring Report 1, and are not repeated herein.

3. Results and Discussion

A comparison of physical and chemical measurements collected in April 1980 with results obtained during April sampling of previous years is provided in Table 4-2. April 1980 data from each sampling station are presented in Appendix 4-1.1.

A comparison of physical and chemical measurements collected in May 1979 and 1980 is provided in Table 4-3. Samples were not collected in May prior to 1979. May 1980 data from each sampling station are presented in Appendix 4-1.2.

The data in Tables 4-2 and 4-3 indicate year-to-year variability in physical and chemical parameters. However, no trends or permanent changes are noted in any given parameter. This variability could have resulted from a number

Table 4-2. Comparison of Physical and Chemical Characteristics of Streams from RBOSC MDP Studies (April 1978, 1979 and 1980) and RBOSC Baseline Studies (April 1975 and 1976)

Parameter	1975	1976	1978	1979	1980
		Station 13			
Water temperature (°C)	9	13	17	15	13
Conductivity (µmhos/cm)	1,730	1,150	1,500	1,050	1,390
Dissolved oxygen (mg/l)	5.2	7.8	5.1	6.3	7.5
Alkalinity, total (mg/l)	716	435	584	450	495
pH	8.3	7.5	8.3	7.8	6.4
Substrate[1/]	Gr,Si	Gr,Sa	Gr	Gr	Gr,Sa
Width	3'	4'	3'6"	4'9"	5'1"
Depth	3"	4"	6"	9"	3"
Velocity (ft/sec)	1.0	1.4	2.0	2.5	1.5

Table 4-2. (Continued)

Parameter	1975	1976	1978	1979	1980
		Station 14			
Water temperature (°C)	5	9	16	17	15
Conductivity (µmhos/cm)	1,800	1,750	1,400	2,000	1,840
Dissolved oxygen (mg/l)	11.1	9.7	10.1	8.5	9.3
Alkalinity, total (mg/l)	492	546	424	600	539
pH	8.4	7.9	8.4	7.0	7.6
Substrate[1/]	Si	Sa	Sa,Si,De	Sa,Si	Gr,Sa,Si
Width	3"	1'6"	6"	8'6"	3'1"
Depth	2"	4"	6"	8"	2"
Velocity (ft/sec)	0.5	1.2	1.0	1.0	1.2

Table 4-2. (Continued)

Parameter	1975	1976	1978	1979	1980
		Station 20			
Water temperature (°C)	14	19	16	22	8
Conductivity (µmhos/cm)	3,700	4,000	4,200	2,500	3,445
Dissolved oxygen (mg/l)	9.4	9.4	8.2	8.7	10.0
Alkalinity, total (mg/l)	1,291	1,632	1,444	1,544	1,355
pH	8.6	8.7	8.1	8.3	8.5
Substrate[1/]	Gr,Si,Sa	Gr	Co,Gr	Gr,Sa	Co,Si,Sa
Width	12'	5'	3'	6'8"	10'4"
Depth	4",3"	4"	4"	5"	3"
Velocity (ft/sec)	1.6,1.0	1.1	1.5	1.3	0.8

Table 4-2. (Continued)

Parameter	1975	1976	1978	1979	1980
		Station 21			
Water temperature (°C)	14	18	13	21	9
Conductivity (µmhos/cm)	3,700	3,900	4,200	3,220	3,540
Dissolved oxygen (mg/l)	8.9	10.2	6.9	8.6	9.7
Alkalinity, total (mg/l)	1,306	1,658	1,532	1,554	1,318
pH	8.6	8.7	8.7	8.4	8.6
Substrate[1/]	Gr,Si	Gr	Gr,Sa	Gr,Sa	Si,Co,Sa
Width	5'5"	6'	4'	9'3"	7'1"
Depth	5",3"	4"	4"	3"	4"
Velocity (ft/sec)	1.3,1.7	0.9	1.0	1.7	2.0

Table 4-2. (Continued)

Parameter	1975	1976	1978	1979	1980
		Station 27			
Water temperature (°C)	15	17	9	11	11
Conductivity (μmhos/cm)	850	650;640;650[2/]	700;700;700[2/]	600;600;600[2/]	620
Dissolved oxygen (mg/l)	9.8	10.6	9.6	9.3	8.0
Alkalinity, total (mg/l)	207	188	184	182	160
pH	8.5	8.4	8.2	7.5	8.2
Substrate[1/]	Gr,Co	Co	Co,Si	Co,Gr	Co,Si
Width	46'6"	51'	51'	54'4"	56'
Depth	2";23";4"[2/]	4";22";8"[2/]	8";10";4"[2/]	14";15";8"[2/]	9";18";12"[2/]
Velocity (ft/sec)	3.0;2.8;2.5[2/]	1.2;1.0;0.7[2/]	1.2;1.9;1.4[2/]	1.9;2.0;1.2[2/]	3.9;3.5;2.3[2/]

Table 4-2. (Continued)

Parameter	1975	1976	1978	1979	1980
		Station 29			
Water temperature (°C)	13	11	9	12	11
Conductivity (µmhos/cm)	850	730;800;1,150[2/]	750;800;900[2/]	600;600;1,000[2/]	1,200
Dissolved oxygen (mg/l)	10.1	10.5	9.3	9.5	8.1
Alkalinity, total (mg/l)	207	186	214	179	341
pH	8.4	8.4	8.2	7.5	8.4
Substrate[1/]	Gr,Sa	Gr,Sa	Co,Si	Gr	Co,Gr,Sa
Width	20'10"	25'	36'	47'6"	33'6"
Depth	1";11";1"[2/]	4";12";2"[2/]	8";10";14"[2/]	10";11";14"[2/]	12";20";18"[2/]
Velocity (ft/sec)	1.9;3.6	2.8;3.9;1.9[2/]	2.4;2.7;2.3[2/]	2.3;3.6;2.1[2/]	4.4;3.5;3.9[2/]

[1/] Substrate abbreviations: Gr = gravel, Sa = sand, Co = cobble, De = detritus, Cl = clay, Si = silt

[2/] Measurements made at side, center, side, respectively

Table 4-3. Comparison of Physical and Chemical Characteristics of Streams from RBOSC MDP Studies (May 1979 and 1980)

Parameter	1979	1980
	Station 13	
Water temperature (°C)	13	11
Conductivity (µmhos/cm)	1,100	1,100
Dissolved oxygen (mg/l)	6.9	7.7
Alkalinity, total (mg/l)	423	378
pH	7.9	7.9
Substrate[1/]	Gr,Co	Co,Si,Gr
Width	6'4"	9'2"
Depth	7"	5"
Velocity (ft/sec)	3.2	3.8
	Station 14	
Water temperature (°C)	9	13
Conductivity (µmhos/cm)	1,500	1,795
Dissolved oxygen (mg/l)	10.6	9.2
Alkalinity, total (mg/l)	529	513
pH	7.4	7.3
Substrate[1/]	Sa	Sa,Si,Gr
Width	9'	4'7"
Depth	5"	6"
Velocity (ft/sec)	0.4	2.2

Table 4-3. (Continued)

Parameter	1979	1980
	Station 20	
Water temperature (°C)	24	22
Conductivity (µmhos/cm)	4,030	3,450
Dissolved oxygen (mg/l)	8.1	8.0
Alkalinity, total (mg/l)	1,620	1,305
pH	8.1	8.6
Substrate[1/]	Gr,Co	Co,Sa
Width	5'4"	10'5"
Depth	6"	3"
Velocity (ft/sec)	2.1	1.8
	Station 21	
Water temperature (°C)	28	23
Conductivity (µmhos/cm)	4,350	3,520
Dissolved oxygen (mg/l)	10.3	7.4
Alkalinity, total (mg/l)	1,590	1,315
pH	8.3	8.6
Substrate[1/]	Gr,Co	Co,Sa,Si
Width	6'4"	6'9"
Depth	4"	4"
Velocity (ft/sec)	1.4	1.8

Table 4-3. (Continued)

Parameter	1979	1980
	Station 27	
Water temperature (°C)	12	12
Conductivity (µmhos/cm)	450	540
Dissolved oxygen (mg/l)	11.5	9.2
Alkalinity, total (mg/l)	130	153
pH	8.0	7.8
Substrate[1/]	Co	Co,Si
Width	--	--
Depth	--	--
Velocity (ft/sec)	--	--
	Station 29	
Water temperature (°C)	12	13
Conductivity (µmhos/cm)	450	710
Dissolved oxygen (mg/l)	11.5	8.5
Alkalinity, total (mg/l)	219	330
pH	8.0	8.3
Substrate[1/]	Co	Co,Si
Width	--	--
Depth	--	--
Velocity (ft/sec)	--	--

(The White River was too high and swift to measure the width, depth and velocity during May 1979 and 1980)

[1/] Substrate abbreviations: Gr = gravel, CO = cobble, Cl = clay, Sa = sand, De = detritis, Si = silt

of factors including amount of runoff from melting of winter snowpack and recent precipitation, ground water injection tests, operational discharge and weather conditions just prior to and during sampling.

B. Water Quality Measurements

1. Objectives

Water quality has important ramifications to the many potential uses of the White River and the distribution and abundance of White River biota. Measurement of certain key chemical parameters at stations along the White River above and below the potential influx of water from the project site will provide an index to water quality. These parameters were selected after evaluating the results obtained during baseline studies and represent the best indicators of natural variability of water quality in the White River. Water quality data in other surface waters of the site are collected during hydrology studies (Section 5).

2. Methods

Methods used to collect and analyze water quality samples were described in RBOSC MDP Monitoring Report 1, and are not repeated herein.

3. Results and Discussion

A comparison of results obtained in the April 1980 water quality analyses of the White River above and below the confluence with Yellow Creek with the data obtained during previous years is provided in Tables 4-4 and 4-5. Results of the April 1980 water quality analyses of the White River above and below the confluence with Yellow Creek are presented in Appendix 4-1.3 A comparison of the results obtained in the May 1979 and 1980 water quality analyses is provided in Tables 4-6 and 4-7. Samples were not collected in May prior to 1979. Results of the May 1980 water quality analyses are presented in Appendix 4-1.4.

Table 4-4. Comparison of Water Quality Data from the White River (Upstream of Yellow Creek) from RBOSC Aquatic Baseline Studies (April 1975) and RBOSC MDP Studies (April 1978, 1979 and 1980) (Results are expressed as the mean of two replicates and are mg/l unless otherwise noted)

Parameter	1975	1978	1979	1980
Boron (B), sol	0.5	< 0.5	< 0.5	< 0.2
Calcium (Ca), sol	66	71	59	51
Chloride (Cl), sol	28	29	22	20
Fluoride (F), sol	0.60	0.27	0.15	0.27
Magnesium (Mg), sol	24	24	20	20
Nitrate (NO_3), sol	< 0.2	< 0.2	< 0.2	0.3
Phosphates, Ortho (PO_4), sol	< 0.01	0.01	0.01	0.07
Phosphates, total (PO_4), sol	0.28	0.02	0.02	0.08
Potassium (K), sol	2.7	2.1	2.0	2.5
Silica (SiO_2), sol	6.1	6.3	6.3	13
Sodium (Na), sol	59	47	39	44
Solids, dissolved	476	444	378	395
Sulfate (SO_4), sol	55	49	40	150
Turbidity (JTU)	93	4	98	575

sol = soluble

JTU = Jackson Turbidity Units

Table 4-5. Comparison of Water Quality Data from the White River (Downstream of Yellow Creek) from RBOSC Aquatic Baseline Studies (April 1975) and RBOSC MDP Studies (April 1978, 1979 and 1980)(Results are expressed as the mean of two replicates and are mg/l unless otherwise noted)

Parameter	1975	1978	1979	1980
Boron (B), sol	< 0.5	< 0.5	< 0.5	< 0.2
Calcium (Ca), sol	62	71	60	51
Chloride (Cl), sol	28	32	31	21
Fluoride (F), sol	0.70	0.28	0.17	0.25
Magnesium (Mg), sol	22	27	20	20
Nitrate (NO_3), sol	< 0.2	< 0.2	< 0.2	0.4
Phosphates, Ortho (PO_4), sol	< 0.01	0.01	< 0.01	0.07
Phosphates, total (PO_4), sol	0.18	0.02	0.02	0.08
Potassium (K), sol	2.6	2.3	2.0	2.6
Silica (SiO_2), sol	6.2	6.3	6.0	13
Sodium (Na), sol	58	64	44	42
Solids, dissolved	467	483	396	413
Sulfate (SO_4), sol	53	51	41	155
Turbidity (JTU)	69	3	103	725

sol = soluble

JTU = Jackson Turbidity Units

Table 4-6. Comparison of Water Quality Data from the White River (Upstream of Yellow Creek) from RBOSC MDP Studies (May 1979 and 1980) (Results are expressed as the mean of two replicates and are mg/l unless otherwise noted)

Parameter	1979	1980
Boron (B), sol	<0.5	<0.2
Calcium (Ca), sol	40	46
Chloride (Cl), sol	3.6	10.7
Fluoride (F), sol	0.12	0.08
Magnesium (Mg), sol	11	15
Nitrate (NO_3), sol	<0.2	<0.2
Phosphates, Ortho (PO_4), sol	<0.01	0.02
Phosphates, total (PO_4), sol	0.26	0.02
Potassium (K), sol	1.6	1.7
Silica (SiO_2), sol	5.4	12
Sodium (Na), sol	17	24
Solids, dissolved	213	258
Sulfate (SO_4),sol	17	77
Turbidity (JTU)	150	160

sol = soluble

JTU = Jackson Turbidity Units

Table 4-7. Comparison of Water Quality Data from the White River (Downstream of Yellow Creek) from RBOSC MDP Studies (May 1979 and 1980) (Results are expressed as the mean of two replicates and are mg/l unless otherwise noted)

Parameter	1979	1980
Boron (B), sol	0.8	0.3
Calcium (Ca), sol	41	44
Chloride (Cl), sol	16.2	29.8
Fluoride (F), sol	0.23	0.35
Magnesium (Mg), sol	21	28
Nitrate (NO_3), sol	2	0.3
Phosphates, Ortho (PO_4), sol	0.01	0.02
Phosphates, total (PO_4), sol	0.03	0.02
Potassium (K), sol	2.0	2.9
Silica (SiO_2), sol	5.5	13
Sodium (Na), sol	77	130
Solids, dissolved	398	606
Sulfate (SO_4), sol	33	170
Turbidity (JTU)	155	150

sol = soluble

JTU = Jackson Turbidity Units

The data in Tables 4-4, 4-5, 4-6, and 4-7 indicate little change in White River water quality from baseline condition. No detectable difference between the water quality above and below Yellow Creek has occurred since the initiation of project activities. During April there was a large fluctuation in turbidity in the four years' samples. However, this fluctuation may have been related to the coincidence of sampling during spring runoff in 1975, 1979, and 1980. The 1978 sampling occurred before the runoff began. Also, an increase in silica and sulfate levels occurred at both White River stations during April and May 1980. These levels are close to the baseline mean for these parameters (RBOSC MDP Report 5).

4.2 BIOTIC COMPONENTS

A. Periphyton

1. Objectives

Sensitivity of periphyton to changes in their environment has been well documented (Cholnoky 1968; Round 1973; Lowe 1974; Hutchinson 1975; Whitton 1975; Patrick 1977). Species composition and relative abundance of the total periphyton community and key periphyton species can provide good indicators of potential project effects on Tract C-a vicinity aquatic systems. Periphyton communities are amenable to sampling techniques which provide a good quantitative data base for identifying changes quickly and accurately. Therefore, the study of periphyton communities is an important part of the MDP Monitoring Program. Species composition, relative abundance, biomass and diversity are the periphyton parameters being measured.

2. Methods

Methods used for identification and enumeration, and biomass determinations were described in RBOSC MDP Report 5, and are not repeated herein. However, the April and May 1980 samples were ashed in a muffle furnace at 450^{o}C rather than at 500^{o}C. Above 500^{o}C some potassium and sodium may be lost. Also, carbon dioxide may be driven from Magnesium Carbonate ($MgCO_3$) and Calcium Carbonate ($CaCO_3$) leaving Magnesium Oxide (MgO) and Calcium Oxide (CaO), thereby reducing accuracy (Cole 1979).

3. Results and Discussion

In April and May 1980, a total of 138 taxa was identified from the periphyton samples. Periphyton identification and enumeration data are provided in Appendix 4-2.1. A listing of taxa encountered at each sampling station is presented in Appendix 4-2.2. Density and biomass calculations are given in Appendices 4-2.3 and 4-2.4. A summary and comparison of mean densities of the most abundant taxa (representing greater than one percent of the total density) from April and May 1980 data with the results from previous April (1975-1979) and May (1979) samples are presented in Tables 4-8 and 4-9. A

Table 4-8. Comparison of Mean Densities of the Most Abundant Species (> 1% of Total Density) in the Periphyton During RBOSC MDP Studies (April 1978, 1979 and 1980) and RBOSC Aquatic Baseline Studies (April 1975 and 1976)

Taxa	Density (Units/mm^2) 1975	1976	1978	1979	1980
	Station 13				
Achnanthes lanceolata	288	-	-	-	26
A. minutissima	4,661	14,765	94	905	31
Bicoeca lacustris	-	631	162	-	-
Fragilaria vaucheriae	-	-	-	364	41
Gomphonema intricatum	-	12,929	-	-	-
Meridion circulare	-	3,240	-	-	5
Navicula arvensis	-	-	25	-	-
N. cryptocephala	830	2,081	14	-	4
N. pelliculosa	-	-	-	-	18
N. secreta var. apiculata	-	15,230	-	-	-
N. viridula	-	-	-	-	70
Nitzschia capitellata	-	1,008	-	-	-
N. frustulum	125	-	23	-	-
N. linearis	-	-	-	-	5
Surirella ovata	-	-	-	-	25
Synedra minuscula	-	-	-	78	-
Phormidium spp.	-	-	-	3,148	61
Total Density[1/]	6,334	52,868	403	4,633	349

Table 4-8. (Continued)

Taxa	Density (Units/mm^2) 1975	1976	1978	1979	1980
	Station 14				
Achnanthes lanceolata	247	-	-	160	50
A. minutissima	4,954	573	-	5,735	600
Bicoeca lacustris	-	3,471	-	-	-
Cymbella affinis	199	-	-	-	-
Gomphonema angustatum	-	-	-	274	-
G. intricatum	-	180	300	-	-
Navicula arvensis	199	177	584	2,590	-
N. cryptocephala	435	339	363	-	-
N. pelliculosa	-	957	607	315	-
N. secreta var. apiculata	-	-	-	200	433
N. viridula	168	-	-	-	17
Nitzschia acicularis	-	-	-	-	30
N. capitellata	-	294	1,642	-	-
N. denticula	1,688	-	-	-	-
N. frustulum	-	-	-	-	-
N. linearis	1,069	-	431	-	20
N. palea	171	-	-	-	-
Synedra amphicephala	135	-	-	-	-
S. fasciculata	-	-	-	111	-
S. minuscula	-	-	-	162	-
S. ulna	-	-	-	-	23
Total Density[1/]	9,929	6,538	4,176	10,163	1,226

Table 4-8. (Continued)

Taxa	Density (Units/mm^2) 1975	1976	1978	1979	1980
	Station 20				
Achnanthes minutissima	1,337	-	6,226	-	36
Cymbella affinis	63	-	-	-	-
Fragilaria capucina	-	-	-	-	21
F. vaucheriae	108	-	-	262	35
Gomphonema olivaceum	-	-	-	35	-
Navicula cryptocephala	-	-	-	-	4
N. pelliculosa	518	1,334	21,965	729	25
N. pygmaea	-	-	-	-	37
N. secreta var. apiculata	-	-	-	-	9
Nitzschia capitellata	-	190	-	-	-
N. fonticola	-	-	-	232	-
N. frustulum	-	-	1,635	-	-
N. holsatica	-	80	-	475	17
N. microcephala	-	-	355	-	-
N. palea	45	-	909	-	10
Nitzschia spp.	-	-	-	29	-
Surirella ovata	243	1,035	-	280	69
Synedra amphicephala	-	1,350	-	-	-
S. minuscula	-	-	-	26	-
Unicellular sulfur bacterium	-	-	-	-	2,637
Total Density[1/]	2,439	4,287	31,436	2,182	2,916

Table 4-8. (Continued)

Taxa	Density (Units/mm^2) 1975	1976	1978	1979	1980
	Station 21				
Achnanthes lanceolata	-	-	-	8	-
A. minutissima	977	114	807	19	-
Fragilaria capucina	-	-	-	-	8
F. vaucheriae	162	118	-	106	26
Gomphonema olivaceum	-	-	-	11	-
Navicula cryptocephala	-	-	-	10	4
N. pelliculosa	3,996	547	15,634	75	-
Nitzschia capitellata	-	283	-	-	-
N. fonticola	-	-	-	25	-
N. frustulum	40	-	851	15	-
N. holsatica	-	136	-	52	7
N. microcephala	-	-	172	-	-
N. palea	58	-	1,791	-	-
Nitzschia spp.	-	-	-	9	-
Surirella ovata	266	1,276	219	124	69
S. ovalis	-	-	-	54	-
Synedra amphicephala	-	1,149	-	-	-
Unicellular sulfur bacterium	-	-	-	-	468
Total Density[1/]	5,647	2,026	19,625	543	597

Table 4-8. (Continued)

Taxa	Density (Units/mm^2) 1975	1976	1978	1979	1980
	Station 27				
Achnanthes minutissima	-	-	-	40	50
Amphora ovalis var. pediculus	-	1,632	-	-	-
Cymbella minuta	-	-	-	19	-
Epithemia sorex	911	1,371	-	110	253
Gomphonema olivaceum	675	-	2,945	292	64
Navicula cryptocephala	2,329	1,144	401	-	103
N. cryptocephala var. veneta	-	-	-	44	-
N. pelliculosa	-	-	1,951	35	-
N. tripunctata	1,463	816	26	-	-
N. viridula	2,767	4,477	403	44	956
Nitzschia dissipata	1,957	1,519	259	29	168
N. fonticola	-	-	-	16	-
N. frustulum	-	997	-	15	-
N. holsatica	-	-	-	15	-
N. palea	-	-	-	-	19
Rhoicosphenia curvata	-	-	-	19	27
Surirella ovata	540	-	-	-	21
Calothrix spp.	-	1,020	-	-	-
Phormidium spp.	-	-	-	143	-
Total Density[1/]	13,790	14,604	6,155	885	1,789

Table 4-8. (Continued)

Taxa	Density (Units/mm^2) 1975	1976	1978	1979	1980
	Station 29				
Achnanthes lanceolata	-	-	-	3	-
A. minutissima	731	-	23	104	169
Amphora ovalis var. pediculus	-	874	3	-	-
A. perpusilla	-	-	-	3	21
Cocconeis placentula	-	-	-	2	43
Cymbella sinuata	-	180	-	-	64
Epithemia sorex	1,192	117	-	-	284
Fragilaria vaucheriae	-	-	-	5	-
Gomphonema olivaceum	574	1,115	1,768	15	138
Navicula cryptocephala	889	540	545	2	48
N. pelliculosa	-	-	1,977	28	-
N. tripunctata	292	204	78	-	-
N. viridula	1,204	2,737	560	13	381
Nitzschia dissipata	1,474	986	590	-	253
N. fonticola	-	-	-	3	27
N. frustulum	101	187	103	-	-
N. palea	-	-	-	-	43
Nitzschia spp.	-	-	-	-	27
Surirella ovata	-	243	3	-	-
Calothrix spp.	157	-	-	-	-
Lyngbya spp.	259	-	-	-	-
Plectonema spp.	250	-	-	-	-
Total Density[1/]	9,294	7,647	5,740	193	1,649

[1/] Total density figure also includes density estimates of less abundant periphyton not listed in the table

Table 4-9. Comparison of Mean Densities of the Most Abundant Species (>1% of Total Density) in the Periphyton During RBOSC MDP Studies (May 1979 and 1980)

Taxa	Density (Units/mm^2) 1979	1980
	Station 13	
Achnanthes lanceolata	-	6
A. minutissima	47	55
Amphora ovalis	-	4
Fragilaria vaucheriae	-	20
Gomphonema parvulum	-	18
Hantzschia amphioxys	-	2
Navicula minima	-	2
N. secreta var. apiculata	3	23
N. viridula	15	8
Nitzschia fonticola	-	5
N. linearis	-	6
Surirella ovalis	-	4
Synedra fasciculata	-	5
Vaucheria sp.	-	3
Phormidium sp.	-	20
Total Density[1/]	246	194

Table 4-9. (Continued)

Taxa	Density (Units/mm^2) 1979	1980
	Station 14	
Achnanthes lanceolata	58	120
A. minutissima	1,004	1,545
Gomphonema parvulum	-	287
Navicula arvensis	76	-
N. pelliculosa	-	594
N. secreta var. apiculata	59	3,449
Nitzschia acicularis	-	859
N. denticula	17	-
N. linearis	-	108
Synedra fasciculata	23	-
Unidentified pennate diatoms	18	-
Cladophora glomerata	-	1,170
Phormidium sp.	65	-
Total Density[1/]	1,390	8,677

Table 4-9. (Continued)

Taxa	Density (Units/mm^2) 1979	1980
	Station 20	
Achnanthes lanceolata	-	6
A. minutissima	38	35
Fragilaria vaucheriae	10	41
Navicula pelliculosa	242	4
N. secreta var. apiculata	-	5
Nitzschia fonticola	168	5
N. frustulum	29	-
N. holsatica	14	10
Surirella ovata	8	21
Unicellular sulfur bacterium	-	132
Total Density[1/]	528	273

Table 4-9. (Continued)

Taxa	Density (Units/mm^2) 1979	1980
	Station 21	
Achnanthes lanceolata	-	12
A. minutissima	14	20
Cyclotella meneghiniana	-	6
Fragilaria vaucheriae	10	84
Navicula pelliculosa	-	-
N. secreta var. apiculata	203	12
Nitzschia fonticola	99	6
N. frustulum	15	-
N. holsatica	-	5
N. linearis	-	5
Surirella ovata	5	84
Unicellular sulfur bacterium	-	138
Total Density[1/]	377	385

[1/] Total density figure also includes density estimates of less abundant periphyton not listed in the table

comparison of mean biomass weights during the 1975-1980 study period is presented in Table 4-10.

Total mean periphyton density volumes varied from 1,789 units/mm^2 at Station 27 in the White River to 349 units/mm^2 at Station 13 in Corral Gulch in April 1980. The total mean periphyton densities in Corral Gulch (Stations 13 and 14) were lower than the values of April samples in previous years. The mean periphyton densities in Yellow Creek (Stations 20 and 21) and the White River (Stations 27 and 29) were higher than the ones for April 1979 but lower than the values of previous years.

The total mean periphyton density values in May 1980 varied from 8,677 units/mm^2 at Station 14 in Corral Gulch to 118 units/mm^2 at Station 29 in the White River. Station 13 in Corral Gulch and Station 20 in Yellow Creek had lower mean periphyton densities in May 1980 than in May 1979, while Station 14 in Corral Gulch and Station 21 in Yellow Creek had higher values. The White River (Stations 27 and 29) was not sampled in May 1979. A similar relationship between total mean periphyton densities occurred between April 1980 and May 1980. Stations 27 and 29 had higher periphyton densities in April 1980 than in May 1980.

At Station 13, Phormidium sp., Achnanthes lanceolata, A. minutissima and Fragilaria vaucheriae were the dominant taxa recorded for April and May 1980. These organisms were also dominant during April 1979. Achnanthes minutissima has been reported dominant at Station 13 throughout the RBOSC baseline and monitoring studies. The periphytic algae which were dominant in 1979 and 1980 are common in this region and characteristic of waters with high alkalinity, high dissolved oxygen and medium organic load where oxidation is proceeding (Lowe 1974). The periphyton which were dominant at Station 13 in previous years are characteristic of a similar environment with perhaps a slightly lower organic load.

At Station 14, Achnanthes minutissima and Navicula secreta var. apiculata dominated the samples in April 1980. Cladophora glomerata along with A. minutissima and N. secreta var. apiculata were the common forms in May 1980.

Table 4-10. Comparison of Mean Periphyton Biomass (Ash-Free Dry Weight) During RBOSC MDP Studies (April 1978; April, May 1979 and 1980) and RBOSC Aquatic Baseline Studies (April 1975 and 1976)[1/]

Station	Biomass (mg/cm^2)						
	1975 April	1976 April	1978 April	1979 April	1979 May	1980 April	1980 May
13	1.018	2.594	0.696	1.737	.585	1.340	.238
14	27.182	1.234	2.940	0.992	1.337	5.413	1.150
20	1.484	0.846	1.572	0.783	.598	1.108	.793
21	2.136	0.754	6.008	1.641	1.016	1.522	.262
27	8.862	6.486	1.040	2.465	---[2/]	11.898	.917
29	6.936	2.330	1.124	0.694	---[2/]	3.158	1.192

[1/] Samples were not collected in May prior to 1979

[2/] Stations 27 and 29 were not sampled for biomass in May 1979

Achnanthes minutissima and Navicula arvensis were the most abundant taxa during April and May 1979. Both of these taxa were reported as abundant or dominant in 1975 and 1976. However, the 1978 community at Station 14 was dissimilar, since several abundant species were present which were unobserved in 1979 or 1980.

Station 14 was a small pond prior to the 1980 sampling. However, after a break in the dam in late winter, Station 14 became a stream habitat during April and May 1980. The dam was not reconstructed until June 1980. This event may explain the differences in the dominant algae found between 1980 and the previous years at Station 14.

At Stations 20 and 21 in the Yellow Creek Fragilaria vaucheriae and Surirella ovata were among the abundant taxa in April 1980. At both stations, these species also were observed as abundant or dominant in previous sampling years. These algae are characteristic of waters with high alkalinity and medium-low organic load (Lowe 1974).

Achnanthes minutissima, Navicula pelliculosa and Nitzschia fonticola were the dominant algae at the Yellow Creek stations in May 1979. Achnanthes minutissima, Fragilaria vaucheriae and Surirella ovata comprised the majority of the algae present at both stations during May 1980. Surirella ovata is reported to have its best development during low water temperatures and usually has its maximum growth in the spring (Round 1973).

A unicellular sulfur bacterium species was very numerous in the samples at Stations 20 and 21. Therefore, its density was included in the sites' total periphyton density. The size and shape of this organism is very similar to that of Navicula pelliculosa. The bacterium was also present in previous years, and its large populations indicate a high concentration of sulfur compounds.

At Stations 27 and 29 in the White River during April 1980 the dominant taxa included Epithemia sorex, Navicula viridula and Nitzschia dissipata. In addition, Gomphonema olivaceum and Achnanthes minutissima were abundant at

Station 29. All of these algae are characteristic of alkaline waters with a medium-low organic load (Lowe 1974). The dominant algae at these stations in past years have been similar to the ones observed in April 1980.

Stations 27 and 29 were not sampled in May 1979. The dominant algae in May 1980 at Station 27 were Epithemia sorex, Navicula viridula and Phormidium sp. with densities of 162, 32 and 30 units/mm^2, respectively. The total algal density at Station 27 during May 1980 was 362 units/mm^2. At Station 29, Achnanthes minutissima, Amphora perpusilla and Gomphonema olivaceum were the dominant species with densities of 16, 45 and 14 units/mm^2, respectively. The total algal density for Station 27 during May 1980 was 118 units/mm^2.

May 1980 biomass values were generally lower than the numbers for April 1980 and May 1979. The biomass values for April 1980 were generally higher than the April 1979 numbers. No trends were readily apparent when compared to previous biomass data for April. However, the White River station downstream from the confluence with Yellow Creek (Station 29) usually had lower biomass volumes than the upstream station (Station 27).

Large spring fluctuation in maximum flow and changes in water temperature may be the driving factors causing the observed variations. High water tends to have a scouring effect on periphyton communities resulting in reduced densities. Conversely, low flow and warm water promote periphyton growth.

Thunderstorm activity in the Corral Gulch (Stations 13 and 14) drainage area just prior to the April sampling date may have caused the reduced density values at these stations compared to previous years. The comparatively higher biomass value at Station 14 in April 1980 could have been caused by an influx of detritus from the exposed pond sediments and the surrounding area during rainfall.

In summary, periphyton densities and biomass were generally higher at the sampling stations during April 1980 than during April 1979. However, the April 1980 periphyton mean densities were lower than in the years prior

to 1979. The April biomass data displays considerable variation over the years. The May 1980 biomass data were generally lower than the data from May 1979 and April 1980. This phenomenon may have been caused in large part by the fluctuations in stream flow from year-to-year and by the increase in stream discharge between April and May 1980. The only discernible trend in the April 1980 data occurred in the White River. Biomass and density appeared to be lower above than below the confluence with Yellow Creek as indicated by comparison of the data from Stations 27 and 29.

B. Benthos

1. Objectives

Benthic macroinvertebrates constitute the major component of the secondary trophic level in aquatic ecosystems on and near Tract C-a. Their limited mobility and well-documented susceptibility to physical and chemical changes in their environment make them an important element of the MDP Monitoring Program (Kolkowitz and Marsson 1909; Hynes 1960; Tarzwell 1965; Cairns and Dickson 1973; Hart and Fuller 1974; Hilsenhoff 1977; Beck 1977; Hubbard and Peters 1978; Harris and Lawrence 1978; Surdick and Gaufin 1978). Data collected on benthos species composition, relative abundance and diversity at all sampling stations will permit the evaluation of development activity on benthos as well as identification of potential impacts on other components of the aquatic system.

2. Methods

Methods used for the benthos sampling program were described in RBOSC MDP Report 5, and are not repeated herein.

3. Results and Discussion

Macroinvertebrate data collected during the April and May 1980 MDP aquatic sampling program are presented in the following manner. Enumeration data and a list of taxa collected at each site are provided in Appendices 4-2.5

and 4-2.6. Macroinvertebrate densities for each site are presented in Appendix 4-2.7. A comparison of April 1980 macroinvertebrate densities with data from April of previous years is provided in Table 4-11. Since sampling of the benthos during May was initiated in 1979, there are no data for May of prior years. Also, sampling in May 1979 and 1980 was limited to the Corral Gulch and Yellow Spring stations because high flow caused by spring runoff, precluded sampling in the White River. The May 1980 macroinvertebrate densities at the Corral Gulch and Yellow Creek stations are compared to the data of the previous year in Table 4-12.

Although the taxonomic composition of the April 1980 samples was similar to the previous April, densities at most sites were greatly increased. A dramatic rise in the collected number of Midge larvae of the family Chironomidae was responsible for the greater densities observed at the Corral Gulch and Yellow Creek Stations in April 1980. Although macroinvertebrate densities in May 1980 were lower than the values of the previous May, the taxonomic composition did not change greatly.

Macroinvertebrate density in April 1980 was much greater at Station 13 in Corral Gulch than in April 1979 or 1978 due to a large increase in the numbers of Chironomidae collected. Diversity remained lower, and Chironomidae and Oligochaeta dominated the macroinvertebrate community. Neither Ephemeroptera nor Plecoptera, which were abundant prior to 1978, were collected in April 1980. Four genera of Chironomidae were present in April 1980 at Station 13 with Cardiocladius and Diamesa the dominant organisms. Procladius and Cricotopus were also represented in the samples. Oligochaeta density in April 1980 was the same as in the previous April. However, their relative importance decreased as a result of the great increase in the Chironomidae. May 1980 macroinvertebrate densities were much lower than in April 1980 at Station 13 due to a decrease in the Chironomidae. Station 13 presents a relatively harsh environment for aquatic organisms. The substrate is unstable and the erosional nature of the stream at this station probably prevents most macroinvertebrate groups from becoming established. Under these conditions, organisms such as Chironomidae and Oligochaeta, which typically have short life cycles as well as the ability to complete several

Table 4-11. Comparison of Major Benthic Macroinvertebrate Taxa Observed During RBOSC Aquatic Monitoring Studies (April, 1977, 1978, 1979 and 1980) and RBOSC Aquatic Baseline Studies (April, 1975 and 1976)

Taxa	Density (Mean Organisms/m^2) 1975	1976	1977	1978	1979	1980
			Station 13			
Nematoda	241	24	9	42	7	-
Oligochaeta	96	18	1,720	150	45	45
Ephemeroptera	2,685	139	63	-	-	-
Plecoptera	91	24	887	-	-	-
Coleoptera	-	-	55	6	-	6
Diptera[1/]	476	24	82	12	7	-
Chironomidae	10,896	1,961	20,245	66	22	1,372
Total [2/]	14,485	2,190	23,061	276	81	1,424
			Station 14			
Nematoda	252	187	NS[3/]	-	7	-
Oligochaeta	3,405	294	NS	994	1,553	401
Ephemeroptera	1,199	24	NS	-	19	91
Trichoptera	-	-	NS	-	26	7
Coleoptera	-	24	NS	126	-	-
Diptera[1/]	710	235	NS	66	26	803
Chironomidae	59,836	16,531	NS	3,270	680	4,434
Total[2/]	65,402	17,295		4,456	2,311	5,748

Table 4-11. (Continued)

Taxa	Density (Mean Organisms/m^2) 1975	1976	1977	1978	1979	1980
			Station 20			
Nematoda	145	320	371	289	-	-
Oligochaeta	627	2,353	154	222	13	-
Ephemeroptera	-	-	9	-	-	-
Plecoptera	-	-	9	-	-	-
Odonata	12	-	-	-	-	-
Diptera[1/]	4,158	102	105	3,165	91	13
Chironomidae	5,750	1,002	2,588	3,336	434	2,226
Total[2/]	10,692	3,777	3,236	7,012	538	2,239
			Station 21			
Nematoda	66	290	NS[3/]	114	-	-
Oligochaeta	18	271	NS	301	7	-
Ephemeroptera	6	-	NS	-	-	-
Plecoptera	6	-	NS	-	-	-
Coleoptera	-	54	NS	-	-	-
Diptera[1/]	1,641	344	NS	2,455	56	26
Chironomidae	5,279	754	NS	2,853	207	1,404
Total[2/]	7,016	1,713		5,723	270	1,430

Table 4-11. (Continued)

Taxa	Density (Mean Organisms/m^2) 1975	1976	1977	1978	1979	1980
			Station 27			
Nematoda	7	13	NS[3/]	19	-	-
Oligochaeta	477	59	NS	1,130	110	214
Ephemeroptera	280	1,698	NS	1,430	511	278
Plecoptera	13	78	NS	65	13	26
Trichoptera	-	72	NS	104	-	65
Diptera[1/]	-	-	NS	46	-	-
Chironomidae	516	558	NS	643	13	13
Total[2/]	1,293	2,478		3,437	647	596
			Station 29			
Nematoda	117	20	136	13	7	-
Oligochaeta	1,615	852	397	648	291	26
Ephemeroptera	742	605	5,077	480	615	971
Plecoptera	91	157	1,485	77	52	123
Trichoptera	189	14	806	71	-	680
Diptera[1/]	52	13	154	69	-	51
Chironomidae	1,331	46	1,166	39	20	32
Total[2/]	4,137	1,707	9,221	1,397	985	1,929

[1/] Diptera other than Chironomidae

[2/] Total density figure also includes density estimates of less abundant taxa not listed in the table

[3/] Station not sampled

Table 4-12. Comparison of Major Benthic Macroinvertebrate Taxa Observed During RBOSC Aquatic Monitoring Studies (May 1979 and 1980) at Stations 13, 14, 20 and 21

Taxa	Density (Mean Organisms/m^2) 1979	1980	1979	1980
	Station 13		Station 14	
Nematoda	-	-	66	13
Oligochaeta	78	7	6,838	401
Ephemeroptera	12	13	12	-
Plecoptera	-	-	-	-
Coleoptera	-	-	-	13
Trichoptera	-	-	-	-
Diptera[1/]	-	13	66	19
Chironomidae	-	19	487	544
Total [2/]	90	52	7,069	997
	Station 20		Station 21	
Nematoda	-	-	-	-
Oligochaeta	12	26	54	45
Ephemeroptera	30	-	-	-
Plecoptera	-	-	-	-
Coleoptera	6	19	42	13
Trichoptera	-	7	-	7
Diptera[1/]	301	71	12	13
Chironomidae	1,943	181	1,288	226
Total [2/]	2,292	304	1,396	304

[1/] Diptera other than Chironomidae

[2/] Total density figure also includes density estimates of less abundant taxa not listed in the table

generations between perturbations, are best adapted to survive.

Diptera and Oligochaeta also dominated the benthic fauna at Station 14 in Corral Gulch in April and May 1980. Chironomidae, the blackfly larvae Simulium and Oligochaeta were the dominant organisms. Macroinvertebrate diversity was greater at Station 14 than at 13, and the taxonomic composition reflected the greater variety of habitats available at the former site. A small dam, which had in previous years created a pond environment, was breached in February 1980 and also affected the benthic community. Species such as Simulium which require running water, and the mayflies Baetis and Ephemerella inermis which favor stream environments were present in greater numbers than in any April since 1975. Although a few of these organisms were collected in previous years, it is likely that they were species which had become dislodged from areas upstream and could not long survive in the pond environment.

In April and May 1980 Stations 20 and 21 in Yellow Creek which are only a short distance apart had very similar benthic faunas. As in previous years, diversity was very low and Diptera were the only macroinvertebrates represented in the April 1980 samples. The Chironomidae Cardiocladius, Orthocladius and Diamesa were the dominant organisms. Although April 1980 densities were much higher than the 1979 values, the May 1980 densities were substantially lower than in the previous year. This apparent shift in the abundance of Chironomidae may have been due to the factors which signal the events in the life history of these organisms. It is likely that normal year-to-year variations in the physical factors such as temperature degree days, flow patterns, etc. which cue hatching and emergence are sufficient to have delayed the Chironomidae life cycles in 1979 compared to 1980 (Hynes 1970; Clifford 1978; Lehmkuhl 1979; Malley and Reynolds 1979; Rosenberg 1979).

In April 1980 the White River Stations, 27 above and 29 below the confluence of Yellow Creek, had abundant and diverse macroinvertebrate populations typical of larger western Colorado streams. Diversity at both stations was greater than in the April 1979 samples. Trichoptera were not collected at

either station in 1979, while in 1980 Hydropsyche larvae were important components of the macroinvertebrate community at each station. As in April 1978 and 1979, Ephemeroptera were the dominant organisms at both stations. Chironomidae were present in low density in contrast to the Yellow Creek and Corral Gulch Stations. Macroinvertebrate abundance and diversity were greater at Station 29 below the confluence of Yellow Creek than at Station 27. Dragonfly nymphs Ophiogomphus, and the Lepidoptera Paragyractis which were present at Station 29 were not collected at Station 27. Although the mayflies Baetis and Ephemerella inermis were abundant at both stations, Rhithrogena which was abundant at Station 27 was not found at Station 29.

In summary, taxonomic diversity remained low at the Corral Gulch and Yellow Creek Stations. The fauna reflects the relatively harsh environment subject to irregular perturbations common to small streams in the Piceance Basin. An abundant and diverse riverine fauna exists at Stations 27 and 29 in the White River, and there was no evidence of any adverse effects upon the macroinvertebrate fauna at the sites sampled below the Yellow Creek confluence.

4.3 SUMMARY AND CONCLUSIONS

The data for the physical parameters measured at each aquatic sampling station varied appreciably from year to year. Measurements for April 1980 fell within the range of the previous years, and no large fluctuations were demonstrated by a comparison of the physical and chemical data obtained in May 1979 and May 1980.

The data for the water quality parameters measured in the White River (Stations 27 and 29) changed very little from baseline conditions. However, increased levels of silica and sulfate occurred at both stations during April and May 1980. The amounts are close to the baseline mean for these parameters. No major differences were found between the water quality data obtained above and below the confluence with Yellow Creek.

April 1980 total mean periphyton densities varied from 1,789 units/mm^2 at Station 27 in the White River to 349 units/mm^2 at Station 13 in Corral Gulch. Total mean periphyton densities in Corral Gulch (Stations 13 and 14) were lower than the values from April samples of previous years. Total mean periphyton densities in Yellow Creek (Stations 20 and 21) and the White River (Stations 27 and 29) were higher than the ones from April 1979 but lower than the densities of previous years.

The total mean periphyton densities in May 1980 varied from 8,677 units/mm^2 at Station 14 in Corral Gulch to 118 units/mm^2 at Station 29 in the White River. Station 13 in Corral Gulch and Station 20 in Yellow Creek had lower mean periphyton densities in May 1980 than in May 1979, while Station 14 in Corral Gulch and Station 21 in Yellow Creek had higher values. The White River (Stations 27 and 29) was not sampled in May 1979. A similar relationship between total mean periphyton densities occurred between April and May 1980. Stations 27 and 29 had higher periphyton densities in the former month than in the latter.

May 1980 biomass values were generally lower than the numbers for April 1980 and May 1979. The biomass values for April 1980 were generally higher than

the April 1979 numbers. No trends were readily apparent when compared to previous biomass data for April. However, the White River station downstream from the confluence with Yellow Creek (Station 29) usually had lower biomass values than the upstream station (Station 21).

In summary, periphyton densities were generally lower at sampling stations during April 1980 than in April samples of previous years. The only discernible trend in April periphyton and biomass data occurred in the White River where biomass and density appeared to be lower below than above the confluence with Yellow Creek. May sampling was initiated in 1979. When comparing the May 1979 and May 1980 biomass and density values, no trends are apparent.

The macroinvertebrate taxonomic diversity remained low at Corral Gulch (Stations 13 and 14) and Yellow Creek (Stations 20 and 21). The fauna reflects the relatively harsh environment subject to irregular perturbations common to small streams in the Piceance Basin. An abundant and diverse riverine fauna exists at Stations 27 and 29 in the White River, and there was no evidence of any adverse effects upon the macroinvertebrate fauna at the sites sampled below the Yellow Creek confluence.

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SECTION 5
HYDROLOGY STUDIES

This report presents the data, findings, and analysis of the hydrologic monitoring program for Tract C-a, for the period of December 1979 through May 1980. The material presented in this report is divided into three (3) general categories: surface water, groundwater, and development activities monitoring.

The surface water and groundwater monitoring programs have been carried out on a continuing basis since the beginning of the baseline period. The purpose of this monitoring program was to detect regional hydrological impacts of the oil shale development activities on Tract C-a. Surface water has been collected from springs and seeps and surface water gaging stations in the general area of the development. Groundwater data have been collected from alluvial monitoring holes and from upper aquifer and lower aquifer wells.

The purpose of the development activities monitoring program is to document the quantity and quality of waters which are displaced as a result of the oil shale development activities. These activities include upper aquifer dewatering, injection of upper aquifer water back into the upper aquifer, discharge of upper aquifer water into surface streams, land-disturbing and other miscellaneous activities that would affect hydrology. The monitoring stations for the development activities monitoring program have been installed as needed, and in the immediate proximity of development activities. This monitoring program was formerly designated the "operational" monitoring program.

The material presented on the following pages describes the data which were collected in each of the three (3) monitoring programs, the analyses of these data, and the conclusions which have been drawn from these analyses regarding hydrologic impacts.

Data were collected at surface gaging stations by the United States Geological Survey (U.S.G.S.). Other data were collected as described herein by RBOSC and its subcontractors. Hydrologic data gathered during the reporting period are presented in Volume 2--Appendices.

5.1 SURFACE WATER

A. Streams

1. Objectives

The objective of the stream monitoring program is to measure and evaluate changes in water quantity and water quality relative to the baseline period.

2. Methods

Surface water quality and quantity are monitored through the use of six surface water gaging stations by the U.S. Geological Survey. The gaging station locations are illustrated on Map 1 (MDP Monitoring Report 4). The description of monitoring gaging stations is shown on Table 5-1. The tributary drainage area and annual runoff for each station are shown on Table 5-2. Conductivity, pH, temperature, and flow are monitored on a continuous basis. Quarterly monitoring includes the major ions (calcium [Ca], magnesium [Mg], sulfate [SO_4], chloride [Cl], potassium [K], bicarbonates [HCO_3], carbonates [CO_3], sodium [Na], and fluoride [F], silica [SiO_2], pH, and alkalinity. Semi-annual analyses are performed for the baseline constituents shown in Table 5-3 at all six surface water gaging stations and surface water impoundments where water is present. In addition to the monitoring done by the U.S.G.S., physical parameters are monitored at Station D on a daily basis by tract personnel because this station is located downstream from tract activities. U.S.G.S. discharge data are included in Appendix 5-1.1 and water quality data are included in Appendix 5-1.2.

3. Results and Discussion

a. Physical parameters - As indicated in Table 5-1, Station A, Dry Fork was dry throughout the December, 1979 - April, 1980 reporting period. Stations C (Box Elder Gulch near the west tract boundary) and E (Box Elder Tributary) were dry during most of the reporting period, except for approximately one week in the middle of February.

Table 5-1 U.S. Geological Survey Surface Gaging Stations
December 1979 - May 1980, Tract C-a.

U.S.G.S. I.D. NO.	Tract Station	Description
09306237	A	Dry Fork near West Tract Boundary-dry during reporting period.
09306235	B	Corral Gulch near West Tract Boundary
09306240	C	Box Elder Gulch near West Tract Boundary-dry throughout most of the reporting period
09306242	D	Corral Gulch near East Tract Boundary
09306241	E	Box Elder Tributary near East Tract Boundary: "Rinky Dink Gulch"-dry throughout most of the reporting period
09306255	F	Yellow Creek near White River

Table 5-2 U.S.G.S. Gaging Stations, Drainage Areas, and Annual Runoff in Acre-Feet 1975 - 1980, Tract C-a.

Station	Drainage Area (sq mi)	Water Year 1975	Water Year 1976	Water Year 1977	Water Year 1978	Water Year 1979	Water Year 1980 1/
A-Dry Fork near West line Tract C-a	2.91	0.2	4.3	11.4	Dry	0.2	Dry
B-Corral Gulch near west line Tract C-a	8.44	96.7	98.5	30.8	107.1	225.4	64.0
C-Box Elder Gulch near west line Tract C-a	10.29	182.8	34.8	13.9	228.4	256.9	.7
D-Corral Gulch near east line Tract C-1	29.59	626.2	418.1	262.8	1339	2381.7	455.4
E-Box Elder tributary east Tract C-1	2.25	0.6	2.3	0.8	Dry	Dry	6.3
F-Yellow Creek near White River	262.00	1158.7	1103.1	925.7	1044.6	1020.8	1228.2

1/ Data for 1980 is only for 6 1/2 months (October, 1979 - mid-April, 1980)

Table 5-3 Water Chemistry Parameters Analyzed Semi-Annually at the Surface Water Gaging Stations and Impoundments During RBOSC MDP Activities, Tract C-a.

Standard Wet Chemical Analysis [1/]

Bromide
Alkalinity
Biological Oxygen Demand
Dissolved Organic Carbon
Boron
Selenium
Calcium
Conductance
Fluoride
Magnesium

Potassium
Silica
Sodium
Chemical Oxygen Demand
Fecal Coliform
Pesticides
Nitrogen, Ammonia
Total Coliform
Strontium
Cyanide

MBAS
Oil & Grease
Sulfate
Ammonia
Bicarbonate
Carbonate
Chloride
Color
Hardness
Dissolved Solids
Suspended Solids
Kjeldahl Nitrogen
Nitrate Plus Nitrite
Odor
Dissolved Phosphate
Turbidity
Dissolved Oxygen
Phenols
Sulfide
pH
Temperature

Radioactivity

Gross Alpha
if 4 pci/l
then Ra^{226}
Natural Uranium

Gross Beta
if 100 pci/l
Then Sr^{90}
Ce^{137}

Silver
Ortho Phosphate
Tin
Aluminum
Arsenic
Cadmium
Chromium
Selenium
Mercury
Zinc
Iron
Lead

Spectrographic Analysis

Molybdenum
Lithium
Manganese
Barium
Beryllium
Germanium
Gallium
Nickel
Titanium
Vanadium
Zirconium
Copper

[1/] To EPA or detectable limits already established

Stream flows at the six U.S.G.S. gaging stations are plotted on a monthly basis for the 1980 water year reporting period and for the previous five water years (see Figures 5-1 through 5-3). Natural flows for the 1980 water year follow the general trends set in water years previous to 1979 which had high flows at several stations. A relatively high flow was recorded at Yellow Creek near White River during February 1980. This can be attributed principally to a flood event that occurred on February 19, 1980. The major surge of the flood occurred off-tract as shown by the increase in flows at Yellow Creek from approximately 1 cfs throughout the winter to 155 cfs on February 19, 1980. Flow at Corral Gulch near the east line of Tract C-a was less than the two previous water years, reflecting the reduction in dewatering discharge that occurred last winter. The maximum annual runoff at Corral Gulch during baseline was 626.2 acre-feet; the runoff during 1979 was 2,382 acre-feet. For the first half of water year 1980 Corral Gulch flow has totalled 455 acre-feet. Water flows for 1980 are indicative of more normal flows. The leading edge (or the point of last noticeable flowing water) of Corral Gulch is measured daily and has been consistently located approximately 1.5 miles below 24 Road Crossing, which is approximately 3 miles east of the tract. As a result, all water flowing down Corral Gulch is absorbed into the alluvium before it reaches the White River.

Figure 5-4 illustrates the overall water balance for Tract C-a. This is a diagram of net outflow from the tract and is calculated by subtracting the four surface inflows at Stations A, B, C, and E from the outflow from the tract recorded at Station D. During drought conditions in early 1974, there was a negative net outflow from the tract. Inflows exceeded outflows, due to recharge of the alluvium, which was dry from lack of precipitation and high evapotranspiration. From 1974 through mid-1978, the net outflow was approximately 25 acre-feet per year. Beginning in late 1978 through mid-1979, net outflows markedly increased from the effects of discharged dewatering water. The mean net outflow from the tract for this time period was approximately 150 acre-feet. The maximum outflow was recorded in March 1979 and was

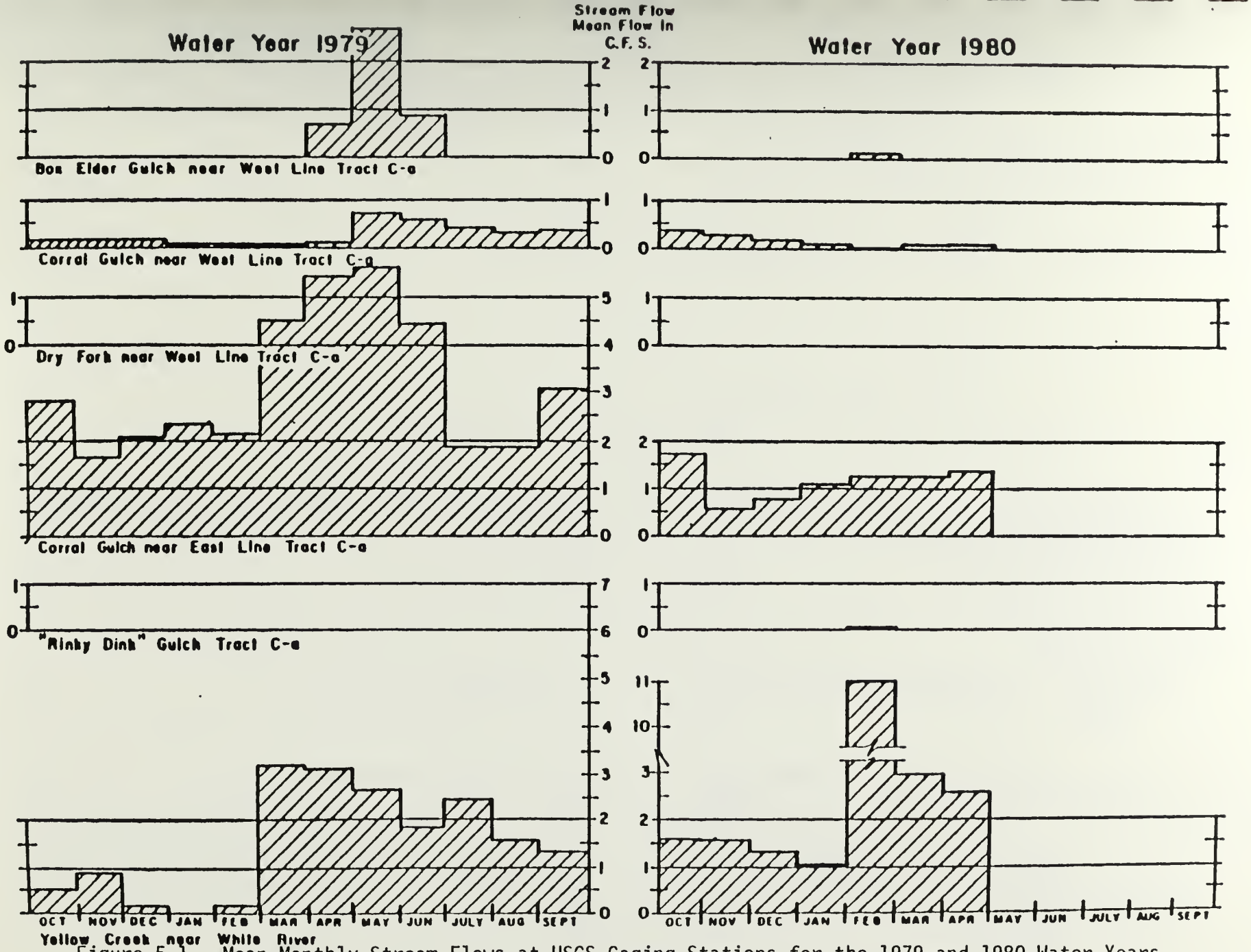
Water Year 1979
Stream Flow
Mean Flow in
C.F.S.
Water Year 1980
Box Elder Gulch near West Line Tract C-a
Corral Gulch near West Line Tract C-a
Dry Fork near West Line Tract C-a
Corral Gulch near East Line Tract C-a
"Rinky Dink" Gulch Tract C-a
Yellow Creek near White River
OCT NOV DEC JAN FEB MAR APR MAY JUN JULY AUG SEPT

Figure 5-1. Mean Monthly Stream Flows at USGS Gaging Stations for the 1979 and 1980 Water Years, Tract C-a.

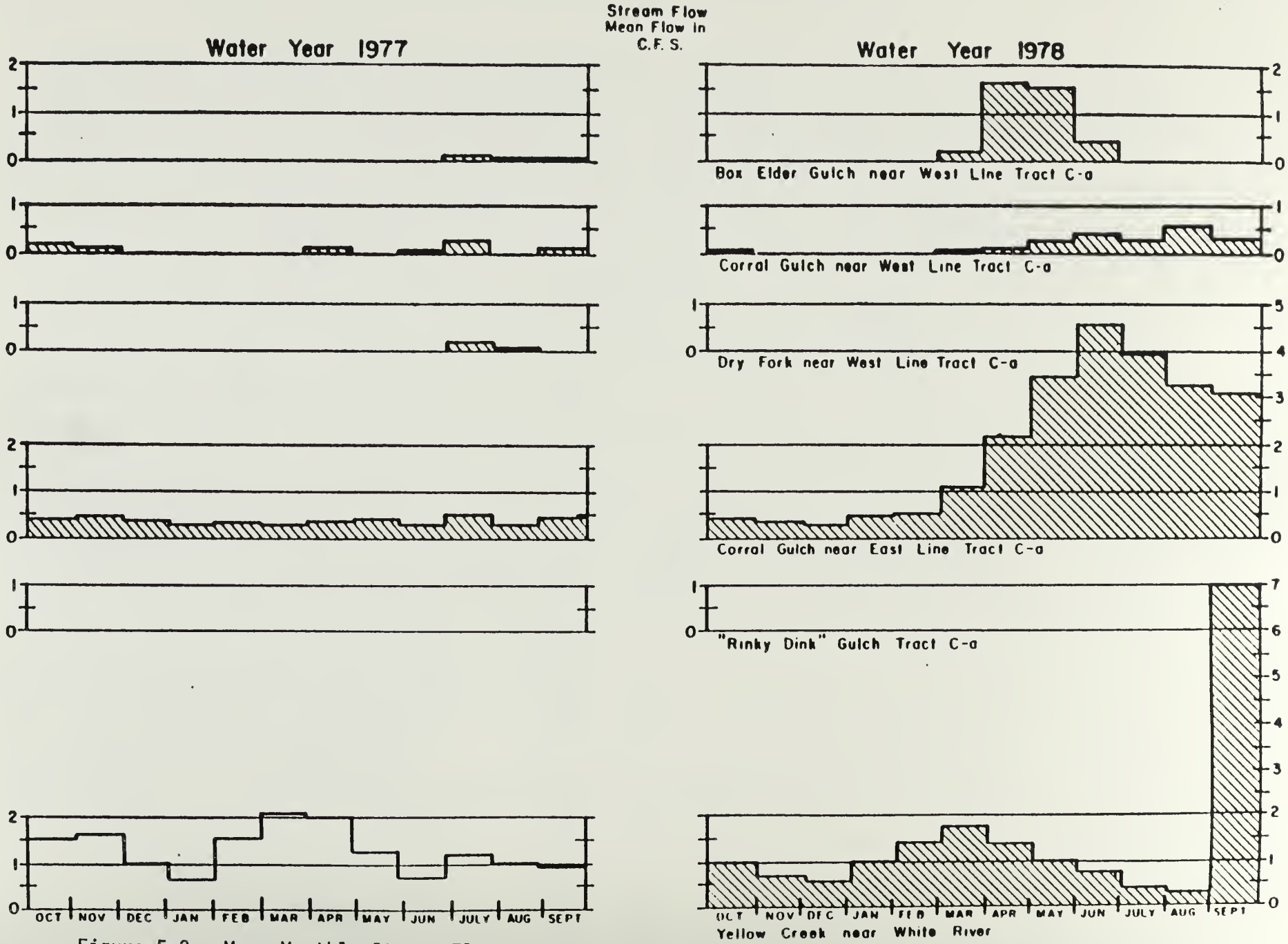
Stream Flow
Mean Flow in
C.F.S.
Water Year 1977
Water Year 1978
Box Elder Gulch near West Line Tract C-a
Corral Gulch near West Line Tract C-a
Dry Fork near West Line Tract C-a
Corral Gulch near East Line Tract C-a
"Rinky Dink" Gulch Tract C-a
Yellow Creek near White River
OCT NOV DEC JAN FEB MAR APR MAY JUN JULY AUG SEPT

Figure 5-2. Mean Monthly Stream Flows at USGS Gaging Stations for the 1977 and 1978 Water Years, Tract C-a.

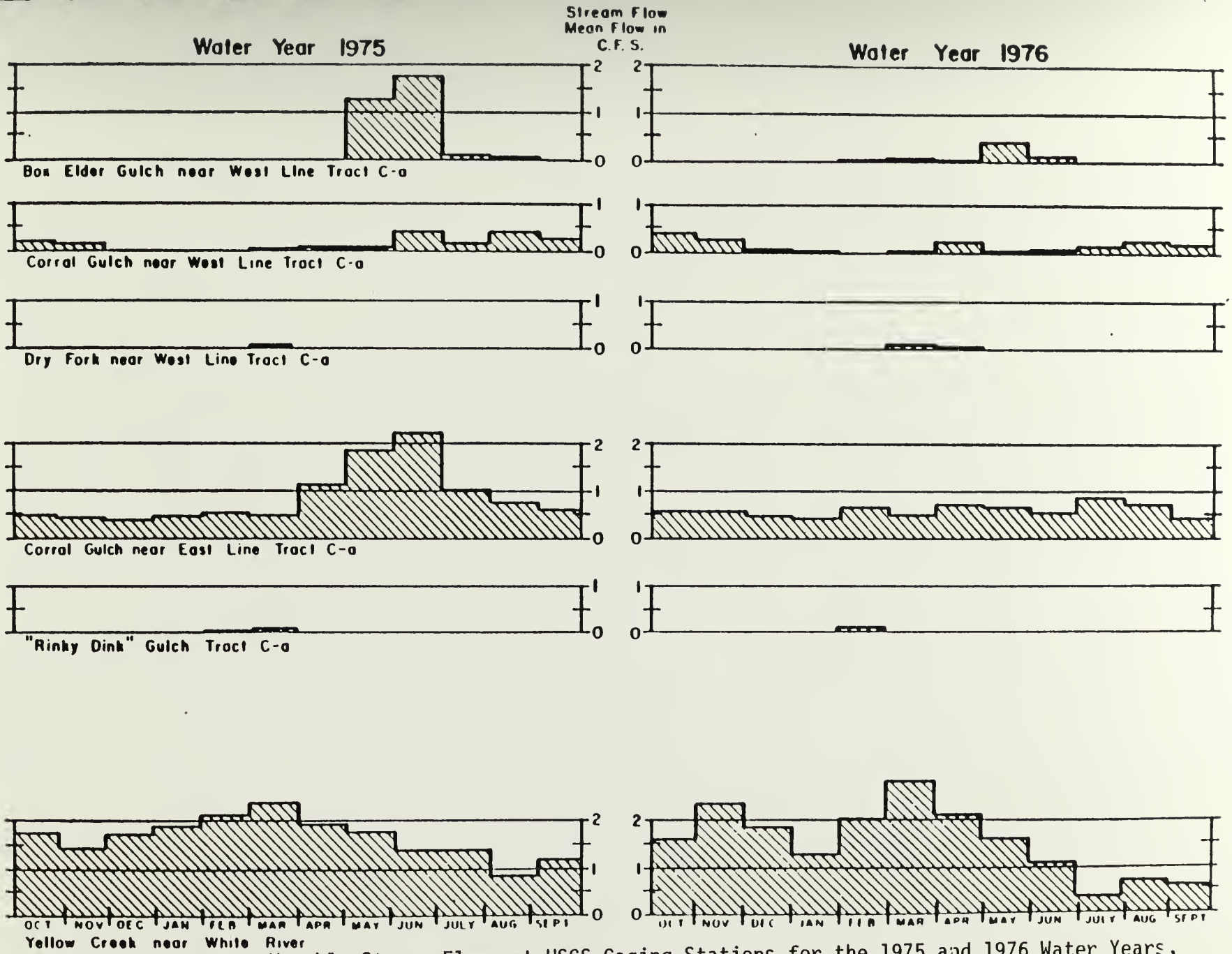
Stream Flow
Mean Flow in
C.F.S.
Water Year 1975
Water Year 1976
Box Elder Gulch near West Line Tract C-a
Corral Gulch near West Line Tract C-a
Dry Fork near West Line Tract C-a
Corral Gulch near East Line Tract C-a
"Rinky Dink" Gulch Tract C-a
Yellow Creek near White River
OCT NOV DEC JAN FEB MAR APR MAY JUN JULY AUG SEPT
0
1
2

Figure 5-3. Mean Monthly Stream Flows at USGS Gaging Stations for the 1975 and 1976 Water Years, Tract C-a.

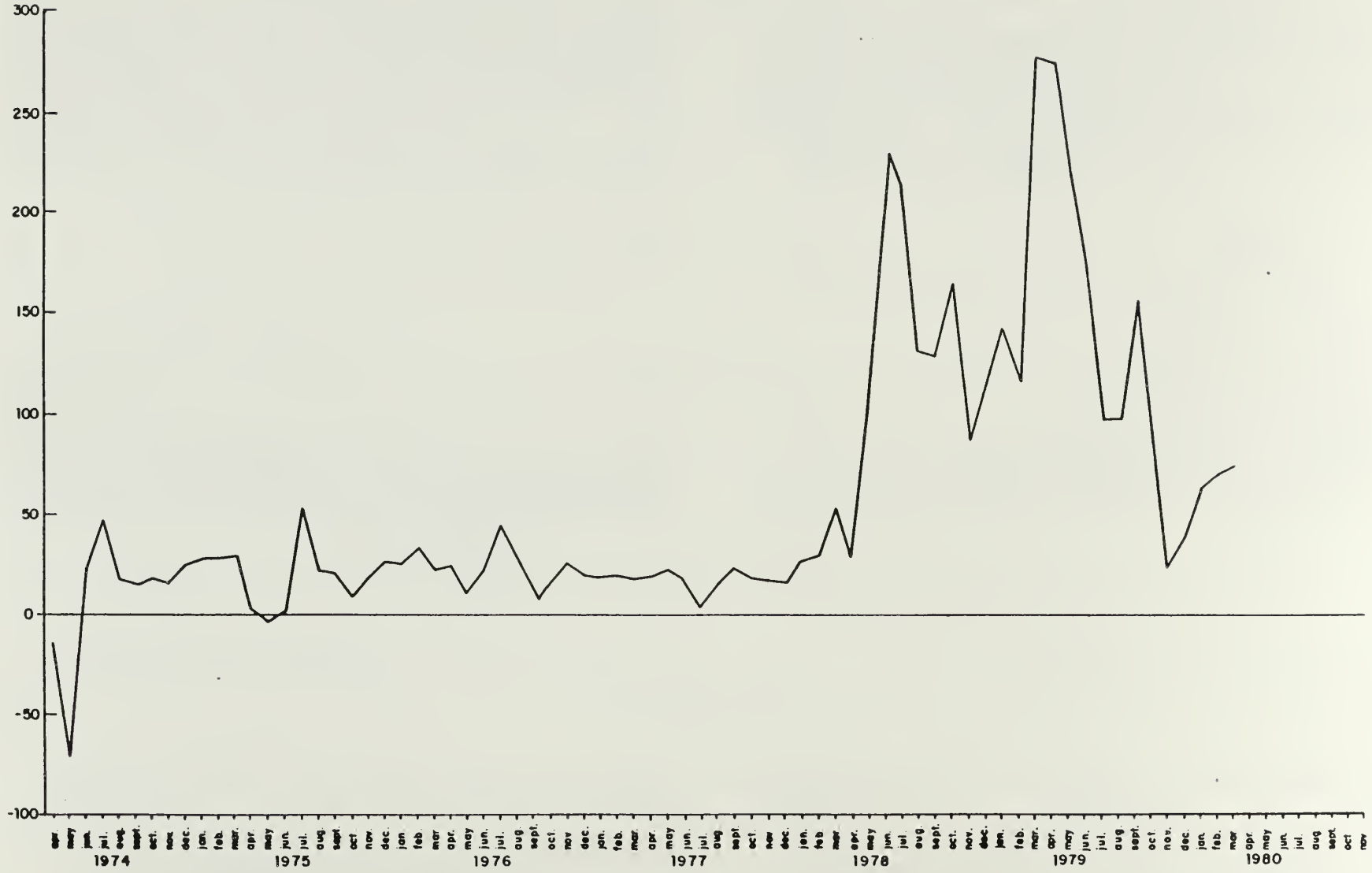

Figure 5-4. Surface Water Net Outflow 1974 - 1980, Tract C-a.

approximately 280 acre-feet. Net outflows have reduced in 1980 to approximately the levels observed prior to the discharge of dewatering water.

b. Chemical Parameters - Quarterly analyses of water quality are reported by the U.S. Geological Survey and are found in Appendix 5-1.2.

B. Springs and Seeps

1. Objectives

The objective of monitoring and observing major springs and seeps is to measure and evaluate changes in the physical parameters (flow, conductivity, temperature, and pH) relative to the baseline period.

2. Methods

Seven springs and seeps were monitored quarterly during the reporting period and are described in Table 5-4. Specific conductance is measured by the use of a conductivity meter. Spring discharge is measured by using a weir, a flume, or integrating cross-sectional velocities. The rationale for measuring flows of springs and seeps is based upon analysis of two years of baseline data, which indicated that the four springs and seeps nearest the tract are hydrologically connected to the upper oil shale aquifer. The two furthest from the tract are hydrologically connected to the alluvium.

Variations in the water quality of the springs and seeps are detected by analyses of conductivity data. The rationale for using conductivity as a detector parameter is based on high correlation with changes in other water quality parameters (calcium [Ca], magnesium [Mg], potassium [K], sodium [Na]) as determined during the statistical analysis of data collected during the baseline monitoring. At each of seven springs and seeps, conductivity measurements were made six times a year during baseline. Water quality data are shown in Appendix 5-1.3.

Table 5-4 Spring and Seep Sampling Stations
December 1979 - May 1980, Tract C-a.

Station	Name	Drainage
#1	Cathedral Bluffs	Box Elder Gulch southwest of Tract
#2	Spruce Gulch	Box Elder Gulch southwest of Tract
#3	Maverick Spring	Corral Gulch west of Tract
#4	Water Gulch	West of Tract
#5	Stake Springs Draw	Southwest of Tract
#8	Box Elder Gulch	On-Tract
#14	84-Ranch	Corral Gulch east of Tract

3. Results and Discussion

A comparison of spring and seep physical data for baseline and average values for 1980 is shown on Tables 5-5. In general, Springs #1 and #2, which are located upgradient from the tract, have exhibited increased flows and reduced conductivities and Spring #14 located downgradient from the tract appears to have reduced flows and increased conductivities during the four years of MDP. The springs near the tract (#3, #4, #5 and #8) have exhibited more regular behavior or mixed trends during MDP. Springs #1 and #2 were inaccessible during January, because of snowpack. All accessible springs were found to be flowing.

When the yearly conductivity values are compared to the baseline values, most fall between the maximum and minimum values. Because the 1980 conductivity values at Spring #14 exceeded the baseline values by over 20 percent, a more comprehensive chemical analysis was conducted and is shown in Table 5-6. This data for Spring #14 exhibits characteristics of upper aquifer water.

Temperature values fluctuate widely and are dependent upon the time of year of sampling. All springs have been inaccessible due to drifting snow at some time during the sampling program and high average temperature values may simply reflect the lack of winter and spring data.

The pH values appear to fluctuate slightly at each spring and seep. The flume for Spring #4 is downstream from the seepage face and relatively high pH's are attributed to decomposition of bicarbonate ($HCO_3^- \longrightarrow CO_2 + OH^-$) under atmospheric pressure.

Table 5-5. Comparison of Spring and Seep Physical Data, Springs #1, #2, #3, #4, #5, #8, and #14 for Baseline and Subsequent Years, Tract C-a

SPRING #1

	Baseline 1975-1976		Average Values			
	Min.	Max	1977[1/]	1978[2/]	1979[2/]	1980[1/]
Flow (gal/minute)			21	26	11	150
Conductivity (umhos)	825	950	920	890	825	750
Temperature (°C)	1	19	6	7.7	7.9	7.7
pH				7.3	7.3	7.1
Dissolved organic carbon (mg/l)	<1	26		9.6	1.0	7.5

SPRING #2

	Baseline 1975-1976		Average Values			
	Min.	Max	1977[1/]	1978[2/]	1979[3/]	1980[1/]
Flow (gal/minute)			13	37	94	495
Conductivity (umhos)	1000	1200	1000	990	923	910
Temperature (°C)	7	11	8	8	8.8	8.0
pH				7.6	7.2	7.5
Dissolved organic carbon (mg/l)	<1	28		6.8	10.0	5.7

SPRING #3

	Baseline 1975-1976		Average Values			
	Min.	Max	1977[1/]	1978[2/]	1979[3/]	1980[2/]
Flow (gal/minute)			21	9	17	37
Conductivity (umhos)	850	1300	1025	1265	1083	1075
Temperature (°C)	5	21	1	6.3	10.3	12
pH				7.3	7.3	7.1
Dissolved organic carbon (mg/l)	<1	60		8.4	4.6	236

Table 5-5. (Continued)

SPRING #4

	Baseline 1975-1976		Average Values			
	Min.	Max	1977	1978	1979[1]	1980[2]
Flow (gal/minute)					94	195
Conductivity (umnos)					1000	1150
Temperature (°C)					10.5	9.2
pH					9.0	8.1
Dissolved organic carbon (mg/l)	<1	42			2.0	9.4

SPRING #5

	Baseline 1975-1976		Average Values			
	Min.	Max	1977[1]	1978[3]	1979[3]	1980[2]
Flow (gal/minute)			43	34	75	109
Conductivity (umhos)	1300	1500	1400	1385	1443	1405
Temperature (°C)	3	22	12	10	9.0	12.6
pH				7.1	7.4	7.9
Dissolved organic carbon (mg/l)	<1	32		8.9	1.5	50.1

SPRING #8

	Baseline 1975-1976		Average Values			
	Min.	Max	1977[1]	1978[4]	1979[2]	1980[2]
Flow (gal/minute)			21	72	65	52
Conductivity (umhos)	850	1100	1140	1018	850	1263
Temperature (°C)	5	12	10.5	11	7.8	14.8
pH				6.9	7.7	7.5
Dissolved organic carbon (mg/l)	<1	34		4.5	<1.0	6.2

Table 5-5. (Continued)

SPRING #14

	Baseline 1975-1976		Average Values			
	Min.	Max	1977[1/]	1978[4/]	1979[2/]	1980[2/]
Flow (gal/minute)			19	269	2	3
Conductivity (umhos)	1550	2000	1750	1427	2333	2625
Temperature (°C)	0	19	3.5	7.6	8.7	11
pH				7.3	7.8	7.8
Dissolved organic carbon (mg/l)				5.1	19.0	125.3

1/ One quarterly reading

2/ Average of two quarterly readings

3/ Average of three quarterly readings

4/ Average of four quarterly readings

Table 5-6 Limited Chemical Analysis of Spring #14
June 6, 1980, Tract C-a

Chemical Paramaters	Analysis (mg/l)
Ammonia	<.3
Calcium	180
Chloride	55
Color (units)	160
Fluoride	.7
Hardness	1280
Iron	.31
Magnesium	203
Nitrate/Nitrite	<.1
Odor	Earthy
Phosphate	.1
Potassium	9.0
TSS	42
Sodium	330
Sulfate	1170

The Dissolved Organic Carbon (DOC) levels fluctuate at all the springs, which is most likely a result of contamination by cattle, leaves and grass after the spring water has reached the surface.

C. Erosion Stations

1. Objectives

The objective of the erosion station monitoring program is to measure and evaluate changes in stream morphology during the modular development phase, and to identify, if possible, the cause of these changes.

2. Methods

Each erosion station is monitored twice monthly. At each station, a stake is located on either side of the channel and measurements of elevation are taken every six inches on a straight line between the two stakes measuring from the left bank looking downstream. The locations of these erosion monitoring stations are shown on Map 1 (see MDP Report 4).

3. Results and Discussion

Channel cross-sections for each of the 10 erosion sedimentation stations are shown on Figures 5-5 through 5-14. On each plot, four cross-sections representing four days spaced throughout the reporting period are shown, rather than all cross-sections which were measured. It would not be possible to superimpose all the data collected on one graph for each cross-section, therefore, four representative cross-sections were selected from the data and plotted, to indicate any changes in channel morphology during the reporting period. In most cases, the four representative cross-sections selected were one to two months apart. Station 1A remained stable; Station 3 exhibited a shifting channel; Station 4 appears to have silted in during the winter and has been scoured out in the spring; Stations 5 and 6 shifted slightly; Station 7 deepened by nearly one foot in December but was filled in by March; Station 8 shifted slightly; Stations 9 and 10 remained stable; and Station 11 deepened by one foot.

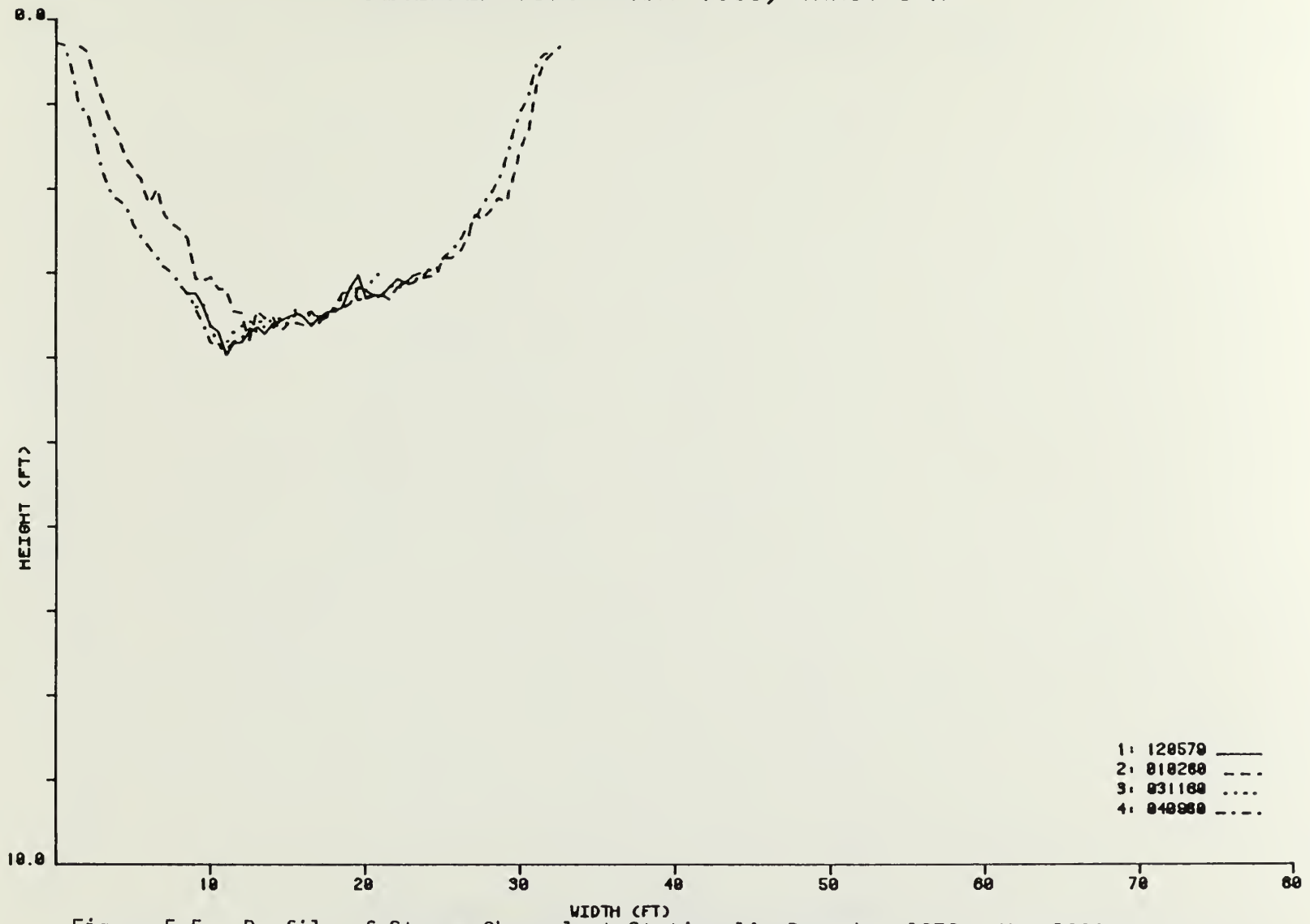

Figure 5-5. Profile of Stream Channel at Station 1A, December 1979 - May 1980, Tract C-a.

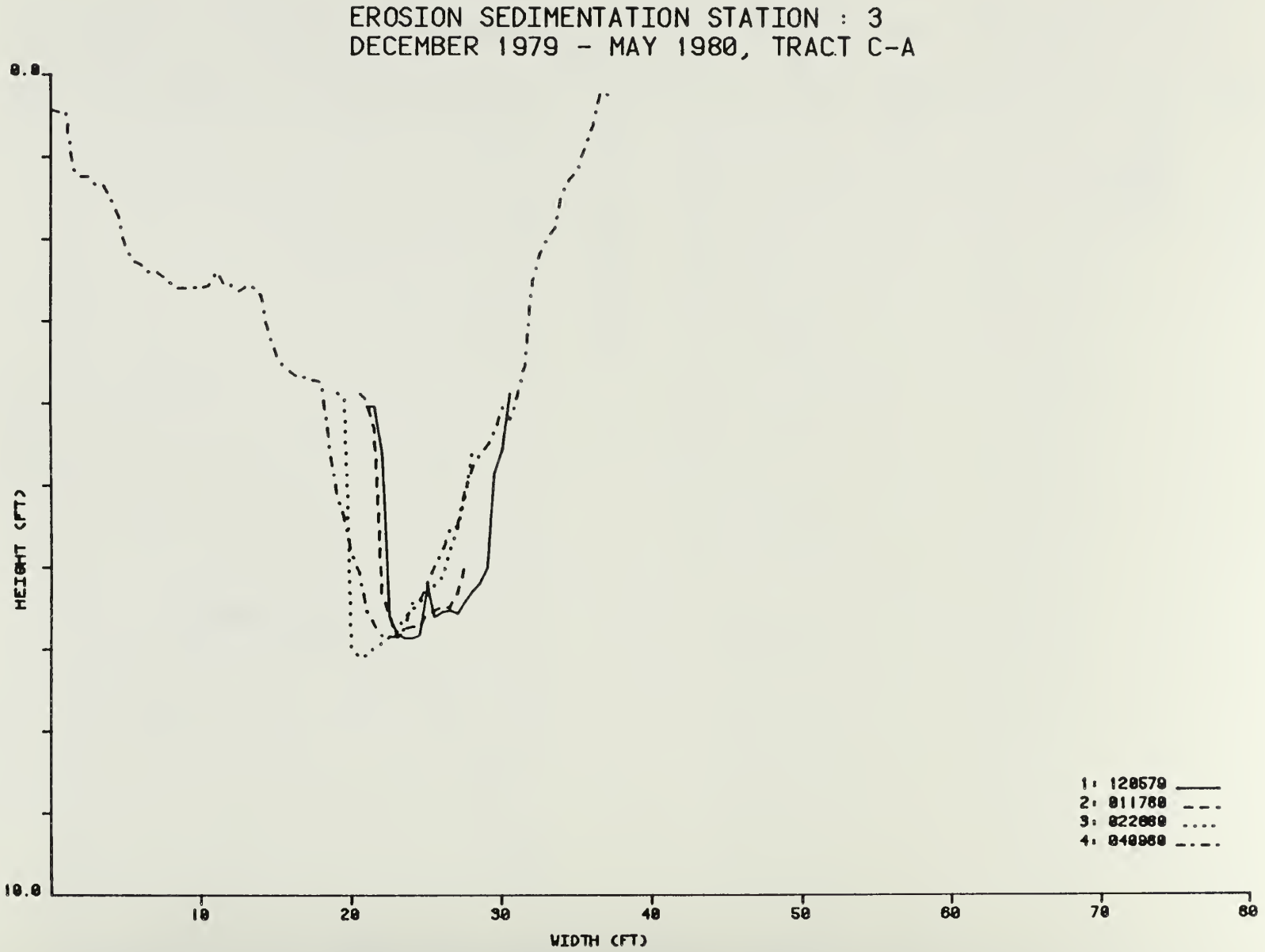

Figure 5-6. Profile of Stream Channel at Station 3, December 1979 - May 1980, Tract C-a.

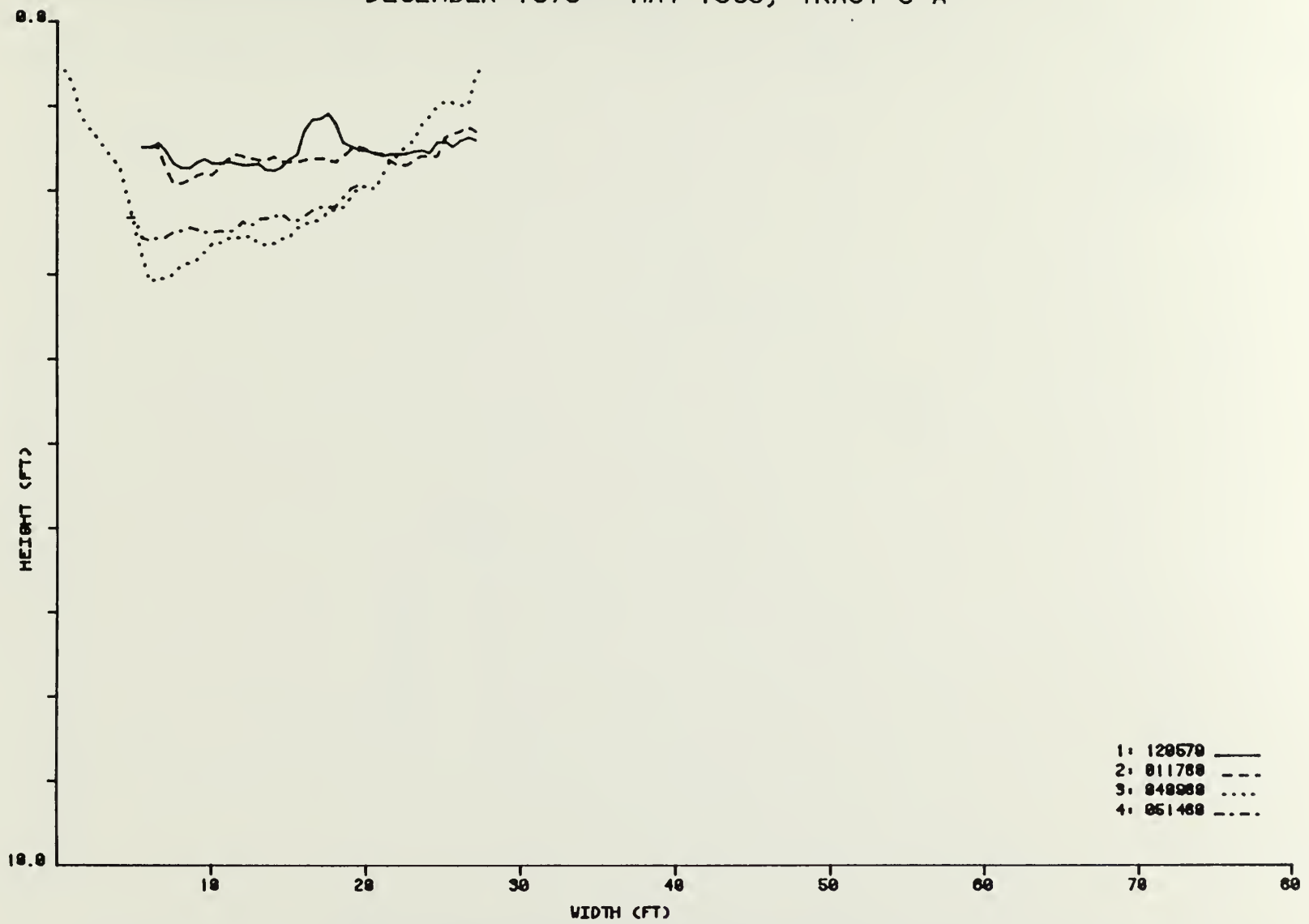

Figure 5-7. Profile of Stream Channel at Station 4, December 1979 - May 1980, Tract C-a.

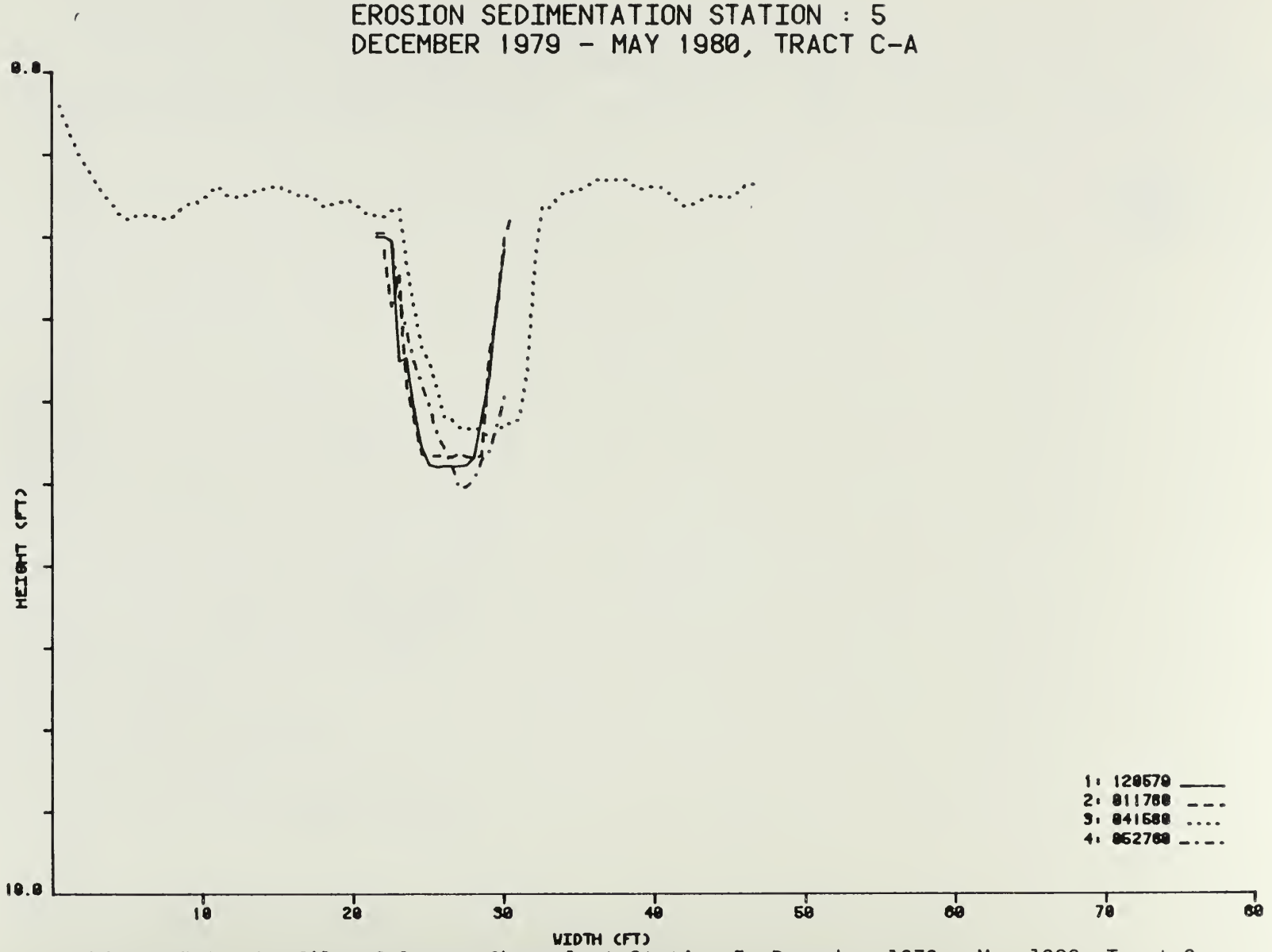

Figure 5-8. Profile of Stream Channel at Station 5, December 1979 - May 1980, Tract C-a.

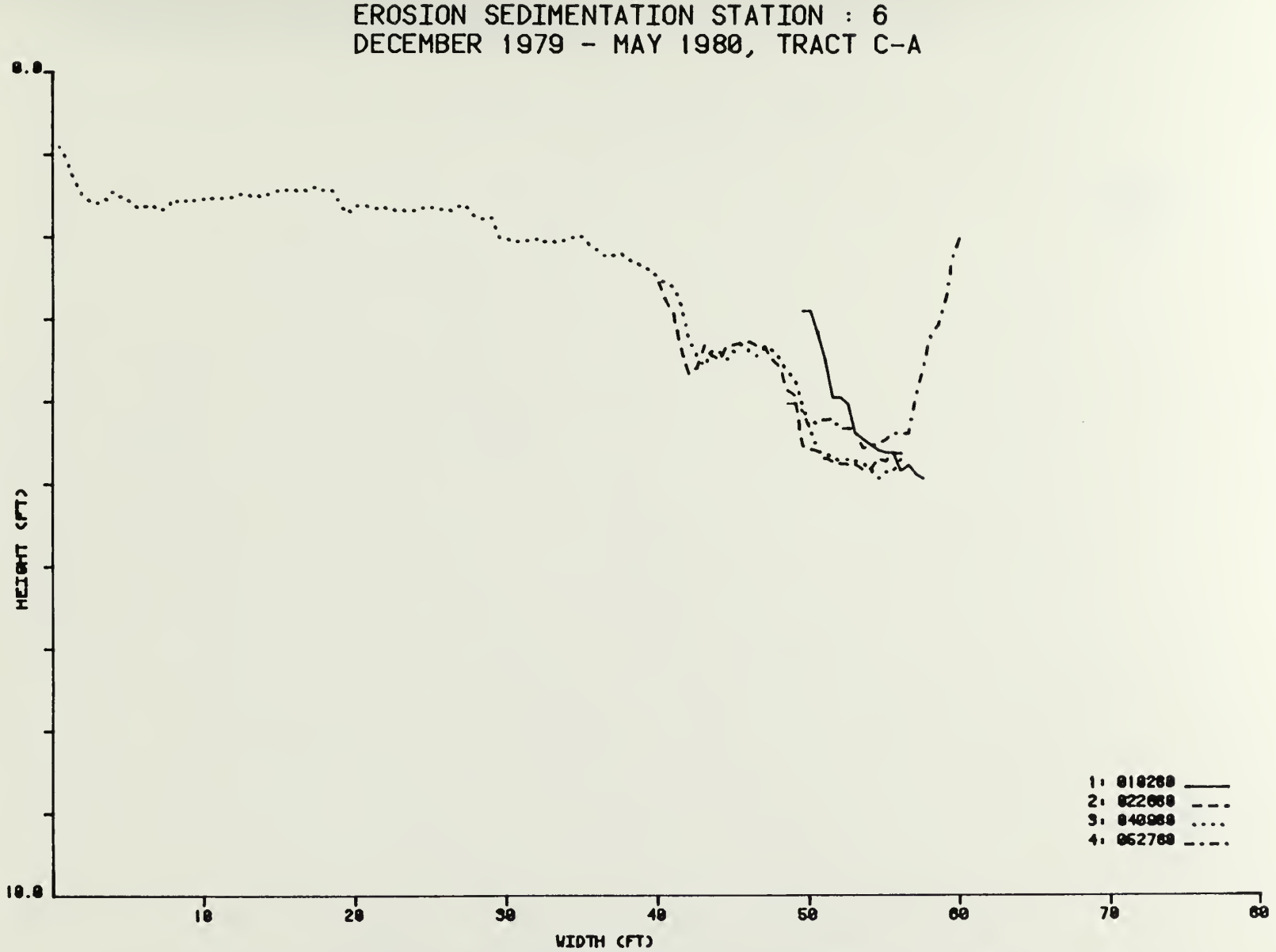

Figure 5-9. Profile of Stream Channel at Station 6, December 1979 - May 1980, Tract C-a.

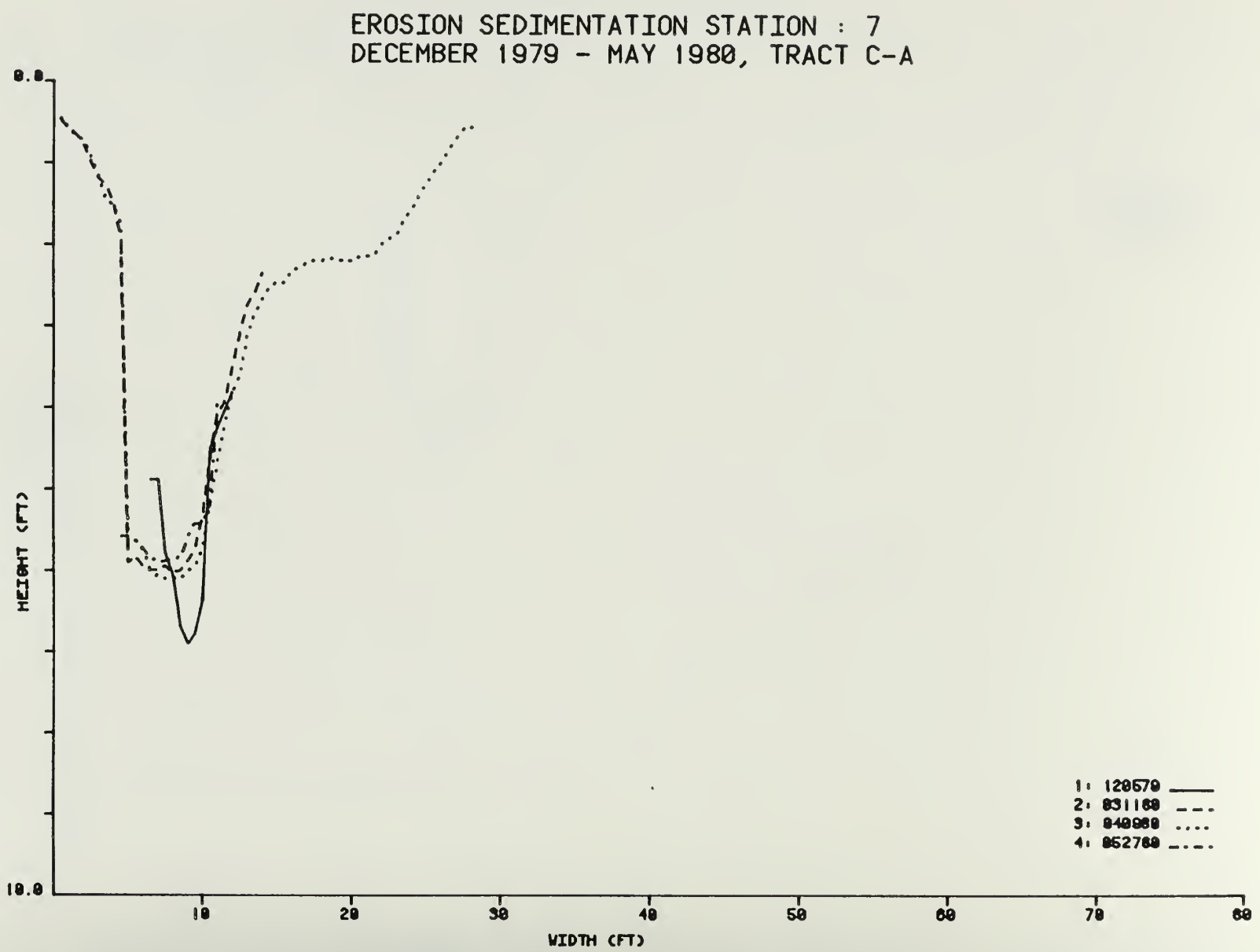

Figure 5-10. Profile of Stream Channel at Station 7, December 1979 - May 1980, Tract C-a.

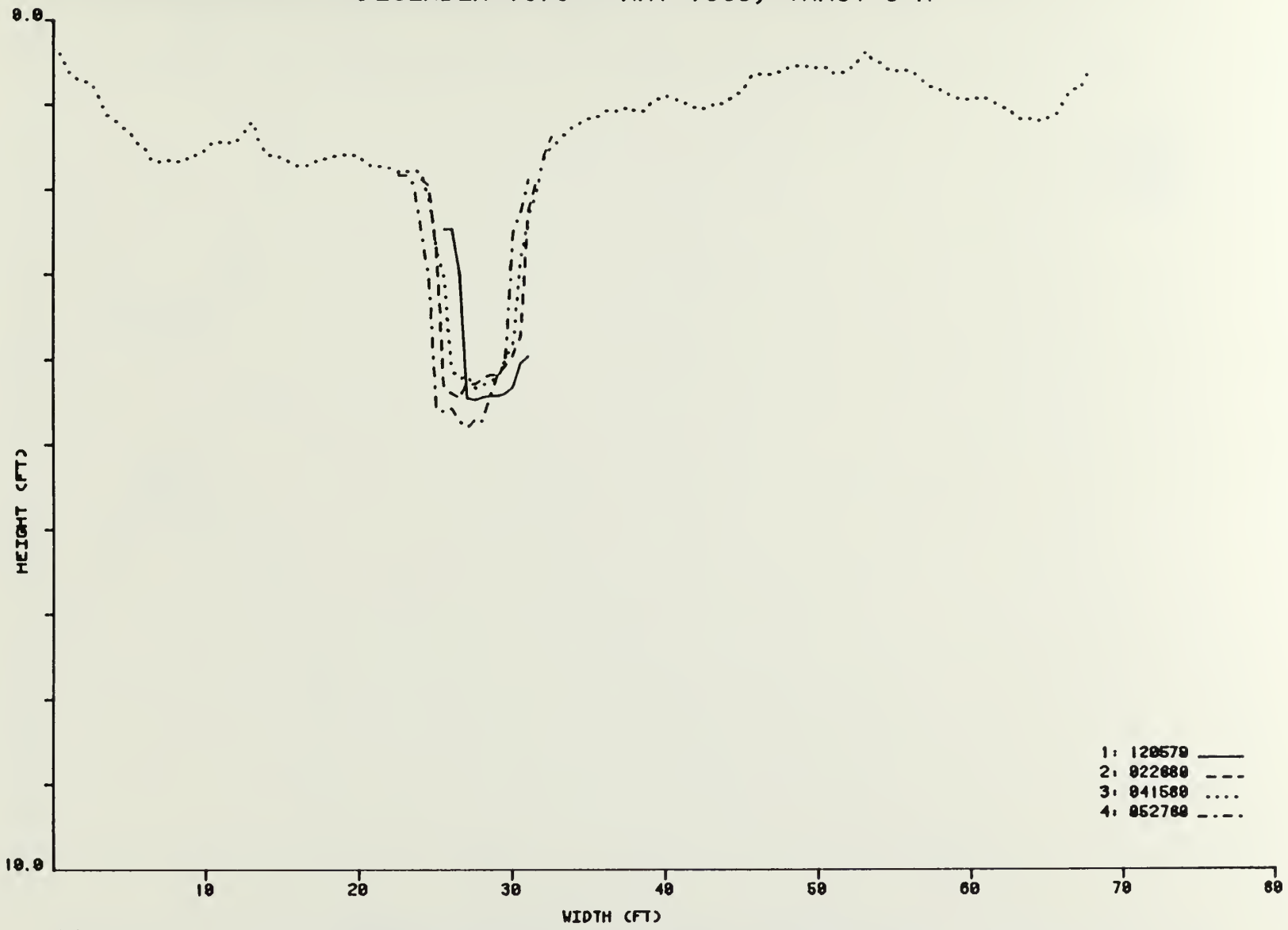

Figure 5-11. Profile of Stream Channel at Station 8, December 1979 - May 1980, Tract C-a.

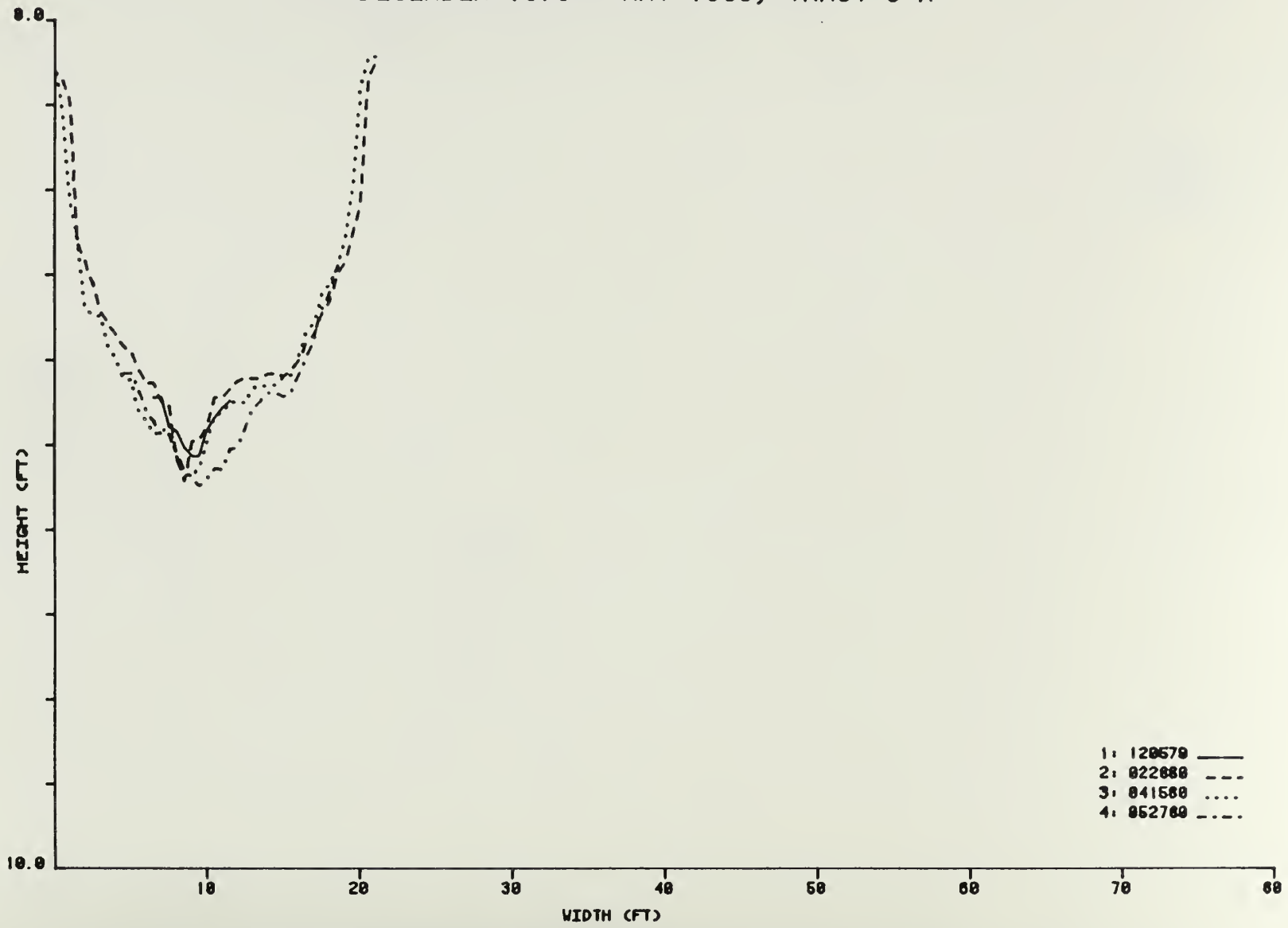

Figure 5-12. Profile of Stream Channel at Station 9, December 1979 - May 1980, Tract C-a

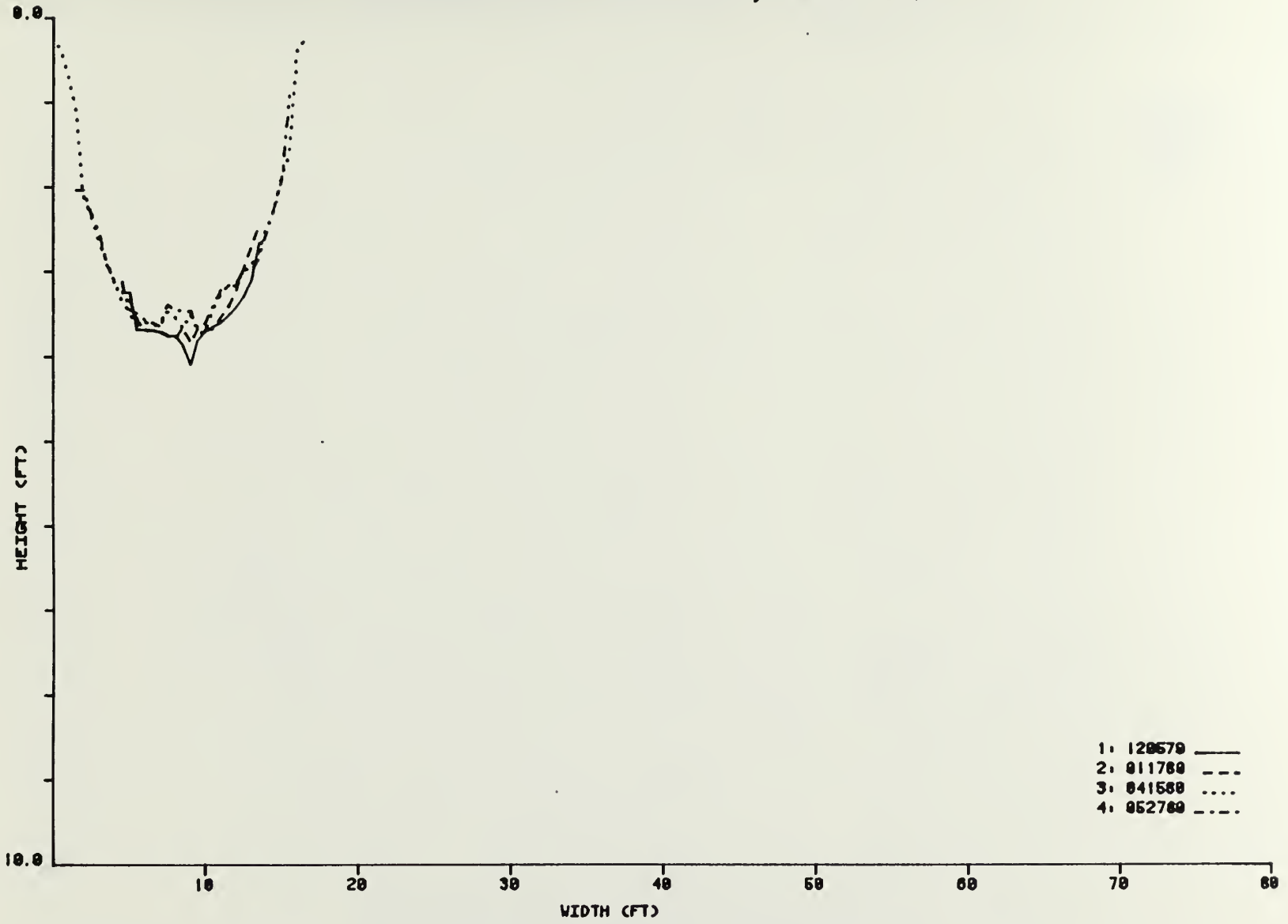

Figure 5-13. Profile of Stream Channel at Station 10, December 1979 - May 1980, Tract C-a.

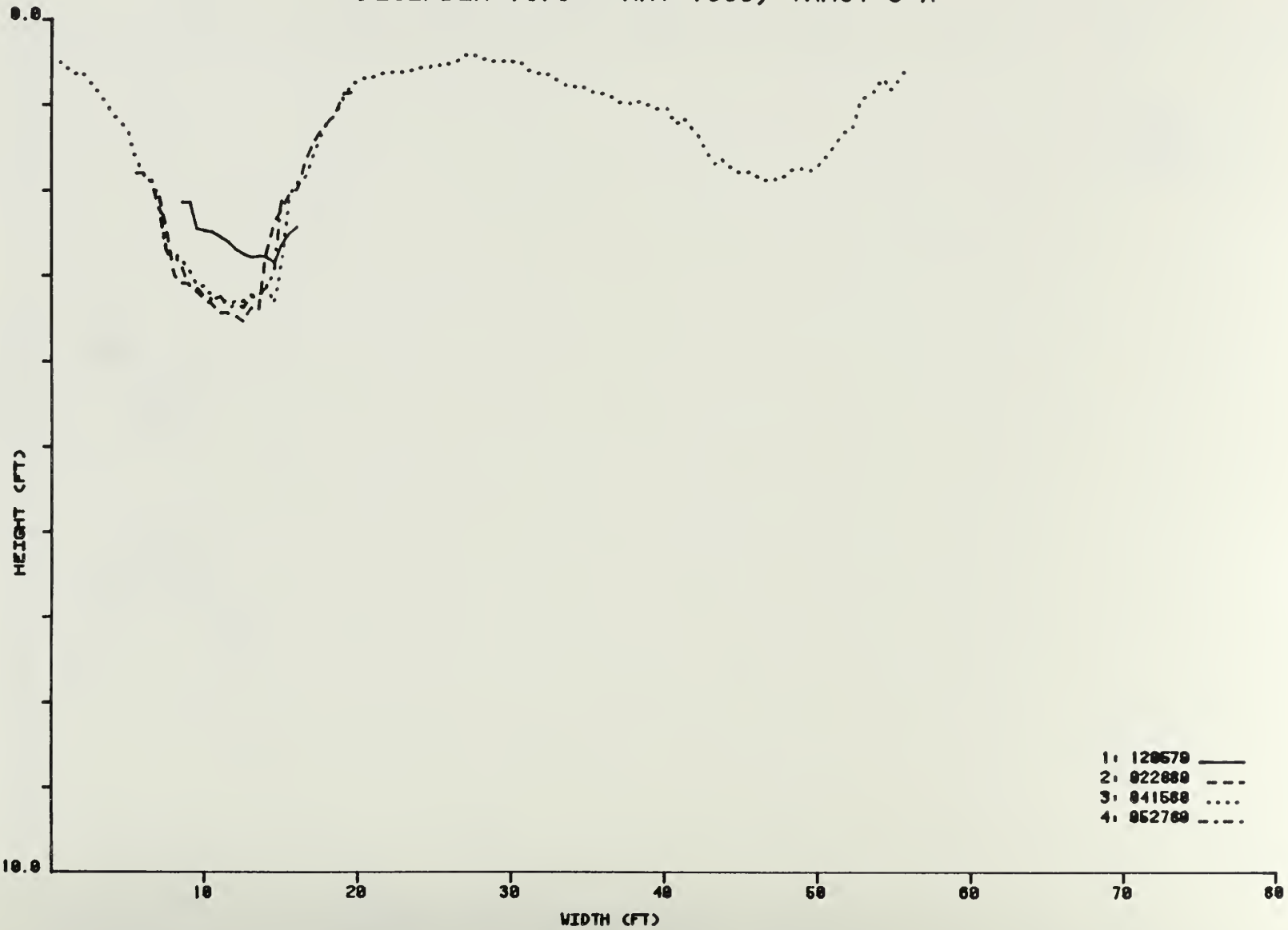

Figure 5-14. Profile of Stream Channel at Station 11, December 1979 - May 1980, Tract C-a.

5.2 GROUNDWATER

A. Alluvial Aquifers

1. Objectives

Alluvial aquifers are being monitored during the Modular Development Phase (MDP) to collect data on water levels and water quality. These data are then analyzed and compared to baseline period data. The purpose of this sampling analysis is to detect changes in the characteristics of the alluvial aquifers, to evaluate the significance of those changes observed and to assess the causes of the changes. An additional objective is to determine if lease and permit requirements are being met.

2. Methods

During the baseline period, seven shallow alluvial monitor holes were drilled and since then, 16 additional monitoring holes have been drilled. Several different monitoring schedules are followed. Water levels are measured daily in nine of these wells. Conductivity, pH, and temperature are measured twice per week in four of these nine holes and twice per month in another three holes. In addition, samples are collected at three stations on a monthly basis and analyzed for pH, conductivity, temperature, alkalinity, bicarbonate, boron, and other major ions. Water levels are measured quarterly at five holes, and other water quality constituents are measured at six holes on a quarterly basis. An extensive water quality analysis is conducted on samples taken semi-annually at nine of the alluvial monitor holes. General cross-sections of the alluvial wells are shown in Figure 5-15 and the alluvial holes are described in Table 5-7.

3. Results and Discussion

a. Physical parameters - Eight of the alluvial monitoring holes were found to be dry during the 1979-1980 reporting period. For the remaining

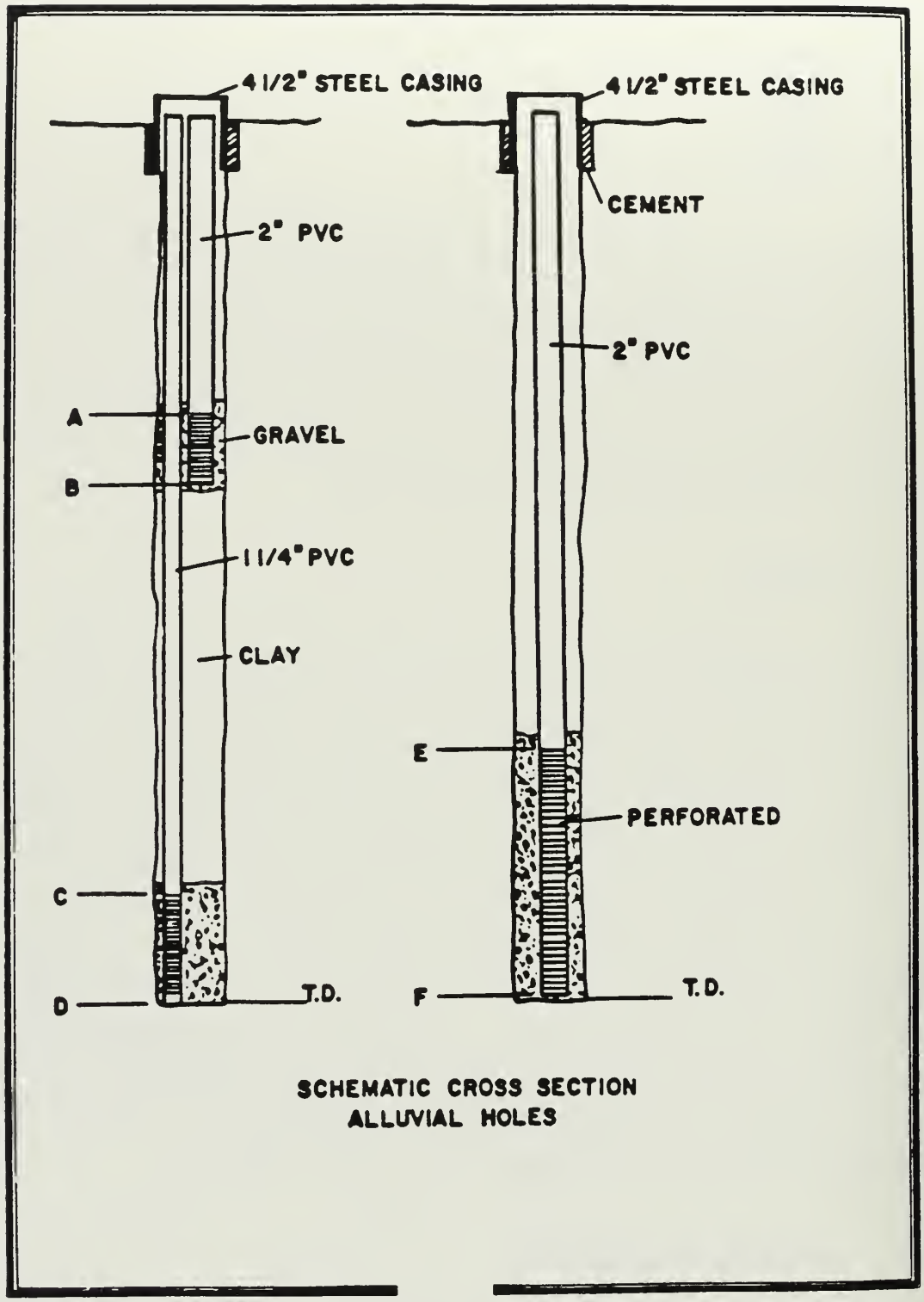

Figure 5-15. Diagramatic (Section) Alluvial Monitoring Hole, Tract C-a

Table 5-7. Alluvial Aquifer Well Descriptions and Completion Intervals, December 1979 - May 1980, Tract C-a

Drainage	Well	Location	T.D.	Completion Intervals Dual Wells A	B	C	D	Single Wells E	F	Comments
Rinky Dink	G-S S13	S.B.	28	-	-	-	-	8	28	Dry
Box Elder Gulch	G-S S8	W.B.	50	-	-	-	-	10	50	Wet
	G-S S14	E.B.	50	-	-	-	-	10	50	Dry
Dry Fork of Corral Gulch	G-S S6	W.B.	12	-	-	-	-	3.5	12	Dry
Corral Gulch	G-S S7	W.B.	44	-	-	-	-	12.5	44	Wet
	G-S S25	C.T.	40	-	-	-	-	30	40	Dry
	G-S S26	C.T.	48	31	34	43	43	-	-	Dry
	G-S S27	E.B.	104	40	45	88	93	-	-	Wet
	G-S S27A	E.B.	16	5	15	-	-	-	-	Dry
	G-S S11A	O.T.	66	34	39	50	58	-	-	Shall-sporadically dry Deep Wet
	G-S S11	O.T.	45	27	37	30	40	-	-	Shall-sporadically dry Deep Dry
	G-S S24	O.T.	75	-	-	-	-	55	75	Wet
Yellow Creek	G-S S28	O.T.	35	10	15	25	30	-	-	Wet
	G-S S28A	O.T.	36	11	16	26	31	-	-	Wet
	G-S S29	O.T.	43	15	20	33	38	-	-	Wet
	G-S S29A	O.T.	44	17	22	34	39	-	-	Wet

E.B. = near East Boundary of Tract
W.B. = near West Boundary of Tract
S.B. = near South Boundary of Tract
C.T. = near Center of Tract
O.T. = Off Tract

Note: All measurements are in feet

alluvial holes, the physical data obtained during this reporting period are listed from upstream to downstream on Box Elder Gulch, Corral Gulch and Yellow Creek, respectively. Hydrographs and graphs for all the alluvial holes are shown in Figures 5-16 through 5-58.

G-S S8 is located in Box Elder Gulch at the west boundary of the tract and reflects the conditions of alluvial water entering the tract. Physical measurements are obtained quarterly. Data for 1980, which are included in Table 5-8, are within the range established during the baseline. During MDP, average water levels and temperatures have increased slightly, pH has decreased, and conductivity peaked in 1979.

G-S S7 is located in Corral Gulch at the west boundary of the tract and reflects conditions of alluvial water entering the tract. The physical data for G-S S7 are plotted in Figure 5-16 through 5-19. Beginning in late January, a small rise in water level lasted one month and then returned to the previous levels. Another increase occurred in May. The temperature increased in March and April. Conductivity and pH remained fairly stable.

During MDP, average water levels have increased and pH has decreased. Conductivity and temperature have fluctuated but the data have remained within baseline ranges as shown on Table 5-8.

G-S S27 is located in Corral Gulch at the east tract boundary and reflects conditions in alluvial water leaving the tract. The physical data are plotted in Figures 5-20 tnrough 5-23. The hydrograph shows a very steady water level throughout the reporting period. A minor rise was measured at the beginning of May. This may be a result of the temporary discharge to Corral Gulch following the addition of the two new dewatering wells. The temperature values fluctuated between 6° C and 11° C. The direction and time of fluctuation generally correlated with G-S S7 but the magnitudes were smaller. The conductivity and pH remained stable over the reporting period with minor fluctuations.

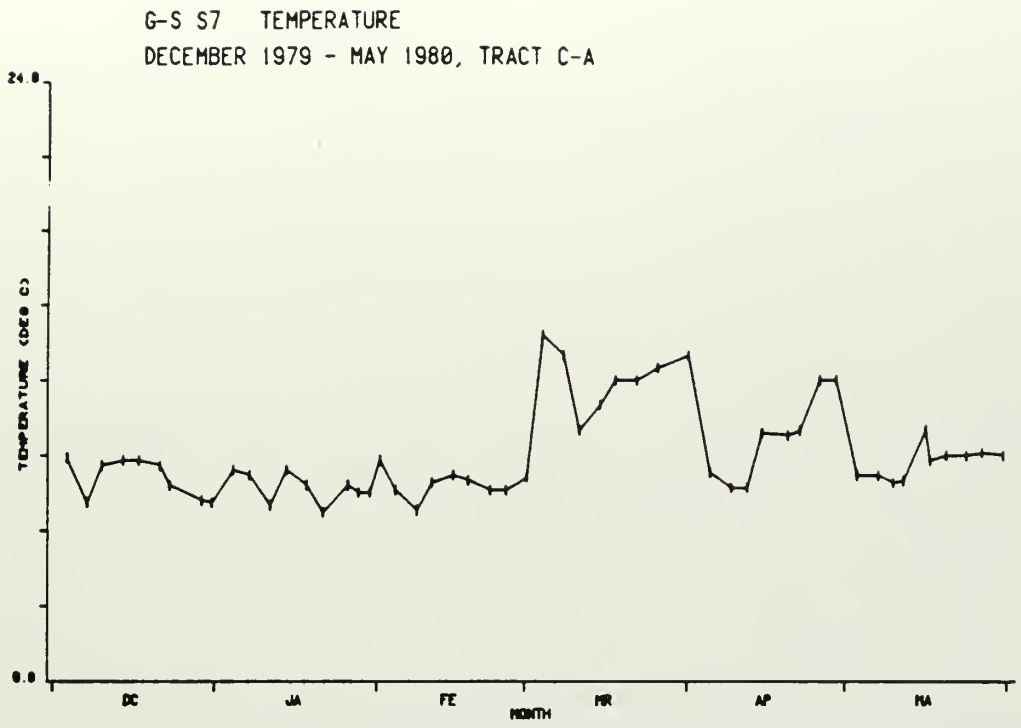

Figure 5-18. Temperature at G-S S7, December 1979 - May 1980, Tract C-a

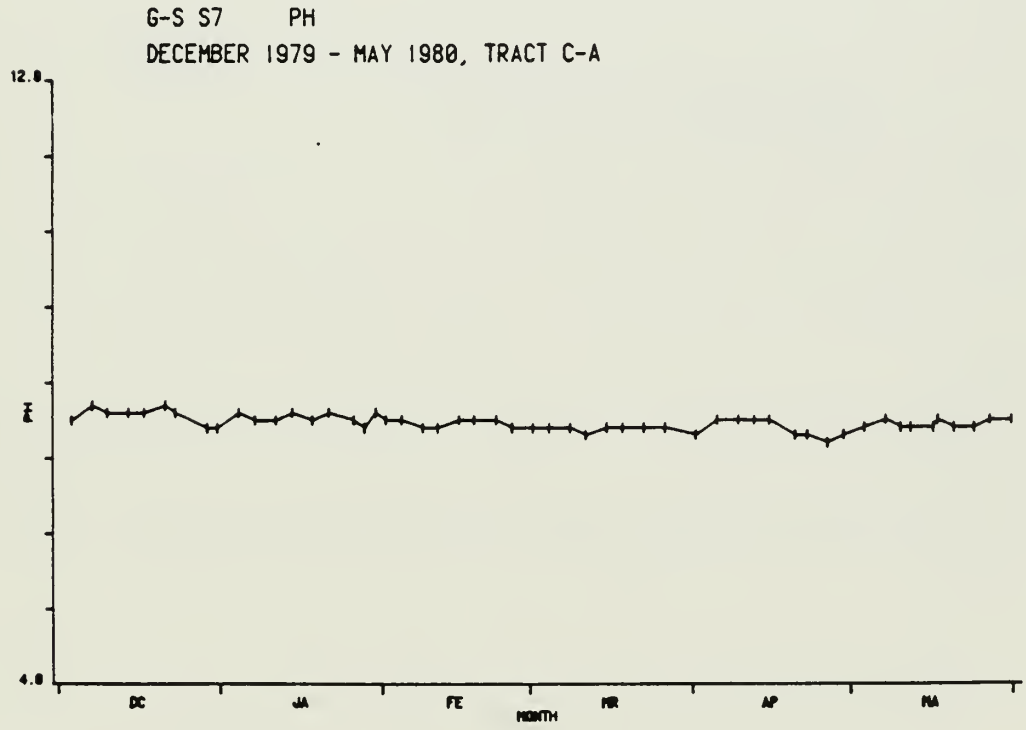

Figure 5-19. pH at G-S S7, December 1979 - May 1980, Tract C-a

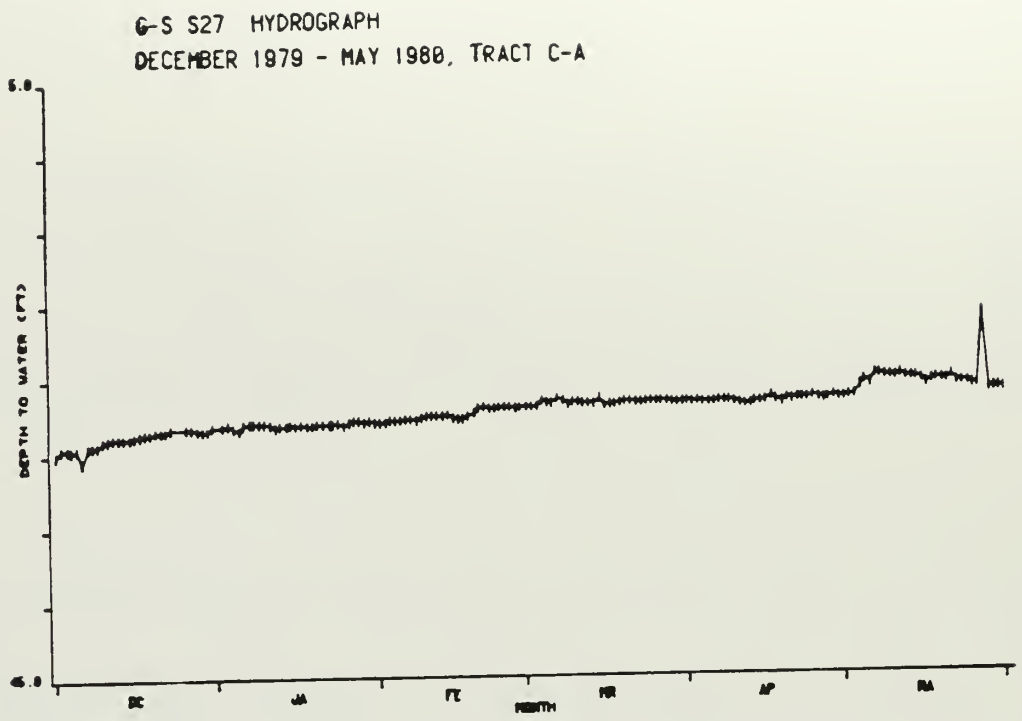

Figure 5-20. Hydrograph of G-S S27, December 1979 - May 1980, Tract C-a

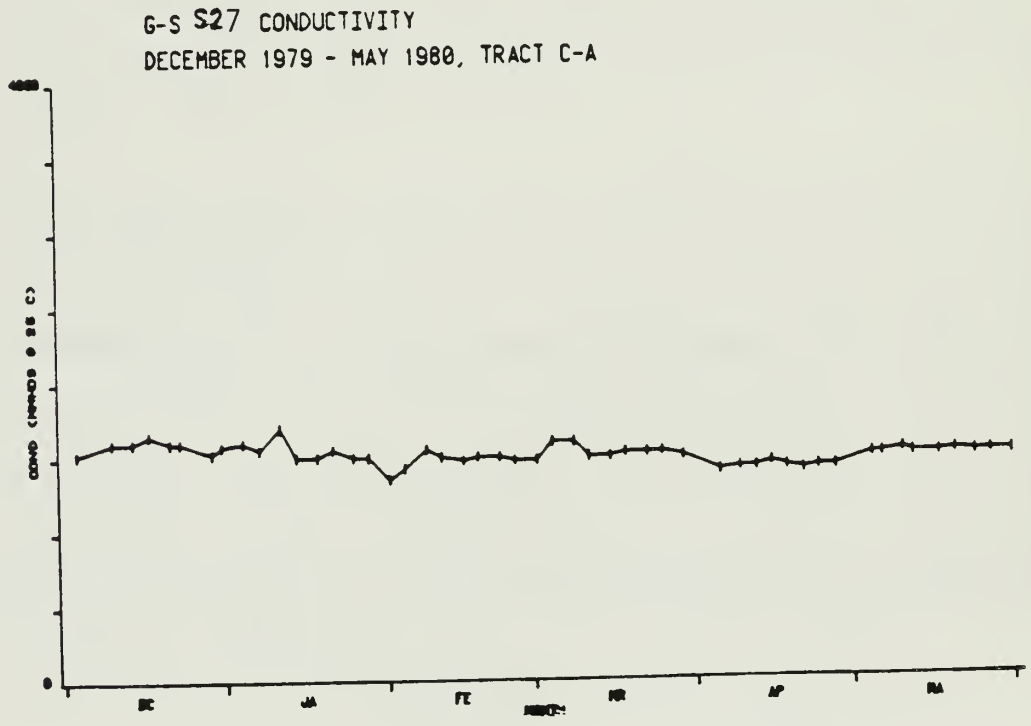

Figure 5-21. Conductivity at G-S S27, December 1979 - May 1980, Tract C-a

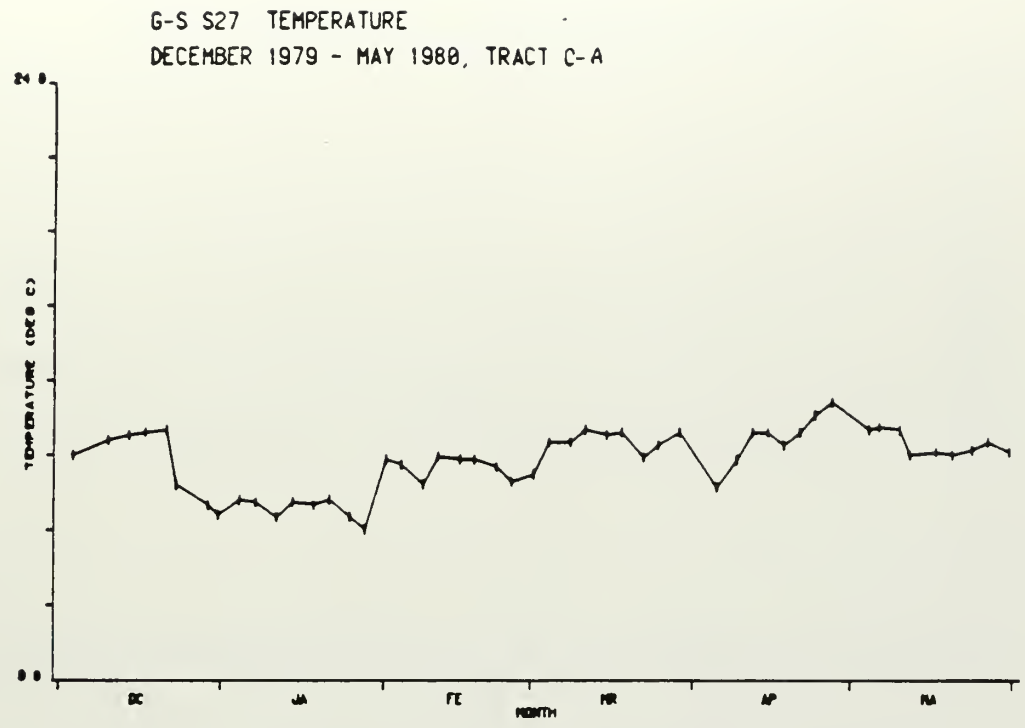

Figure 5-22. Temperature at G-S S27, December 1979 - May 1980, Tract C-a

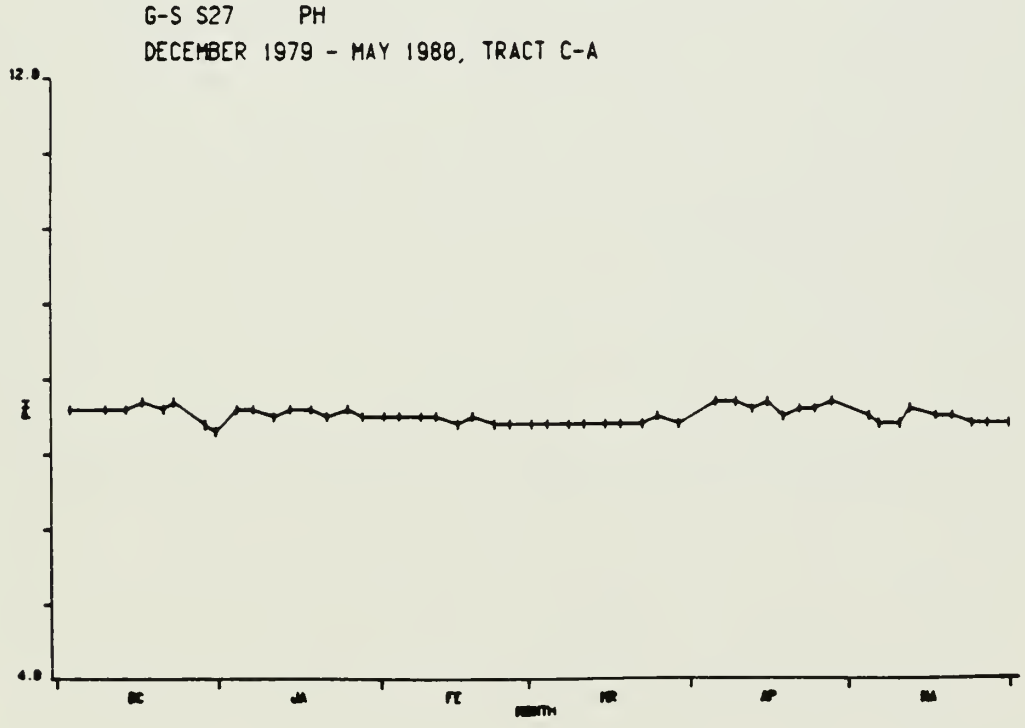

Figure 5-23. pH at G-S S27, December 1979 - May 1980, Tract C-a

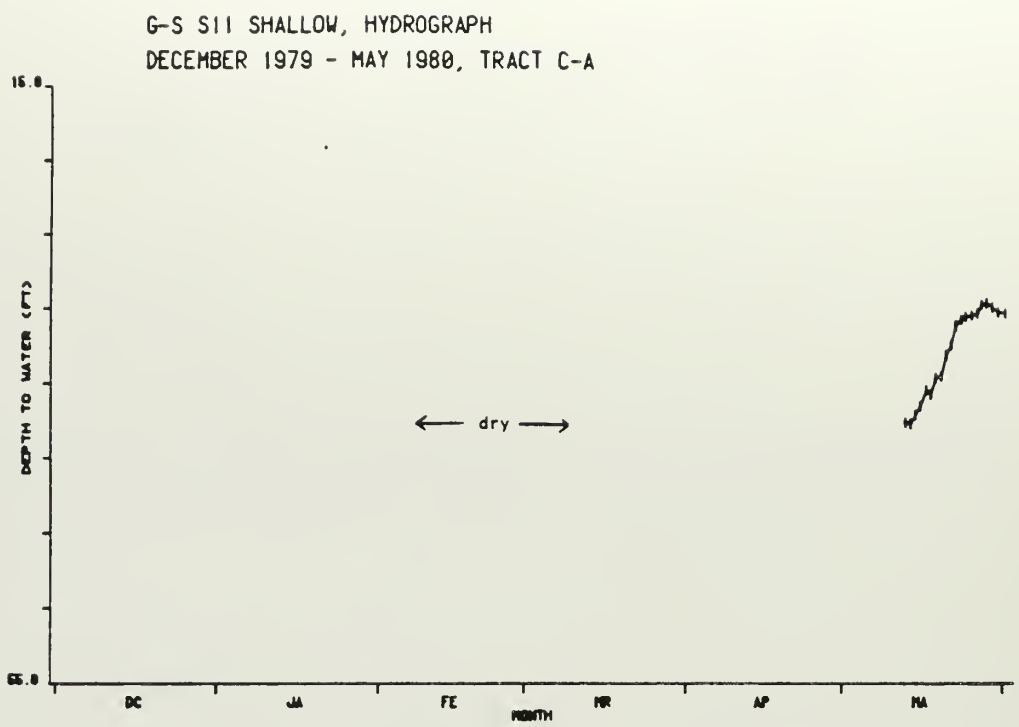

Figure 5-24. Hydrograph of G-S S11 Shallow, December 1979 - May 1980, Tract C-a

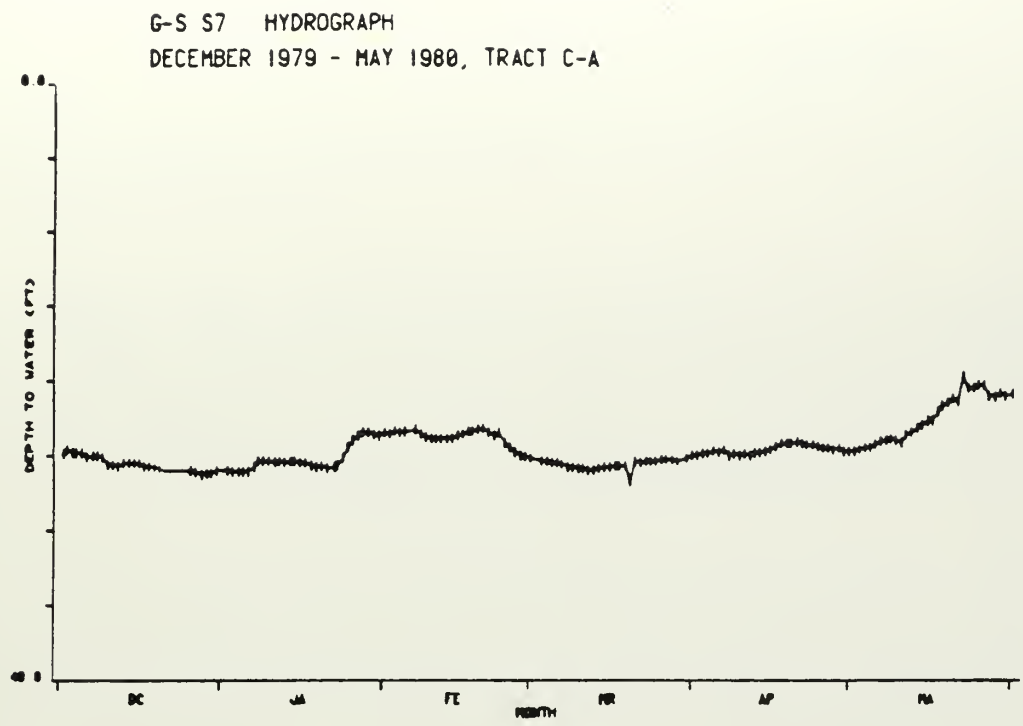

Figure 5-16. Hydrograph of G-S S7, December 1979 - May 1980, Tract C-a

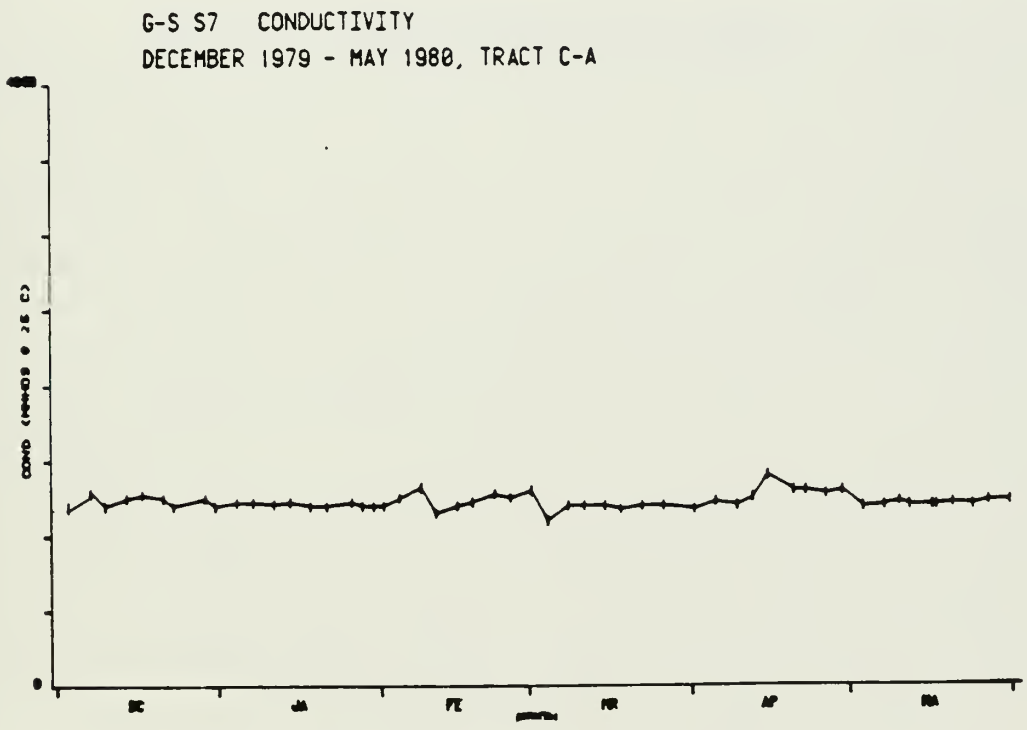

Figure 5-17. Conductivity at G-S S7, December 1979 - May 1980, Tract C-a

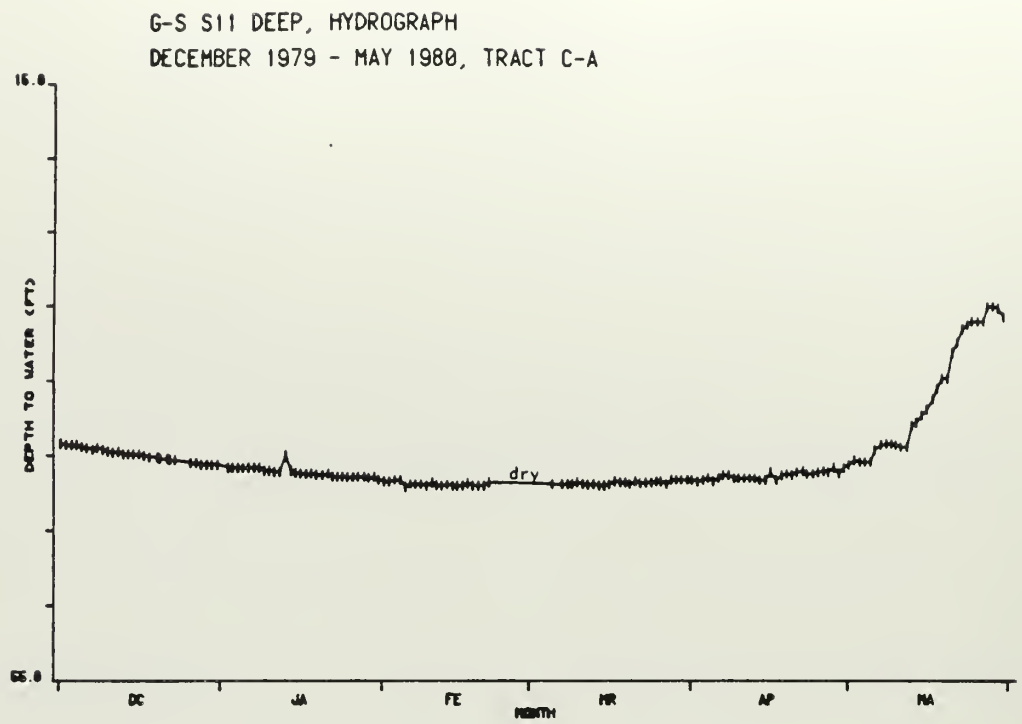

Figure 5-25. Hydrograph of G-S S11 Deep, December 1979 - May 1980, Tract C-a

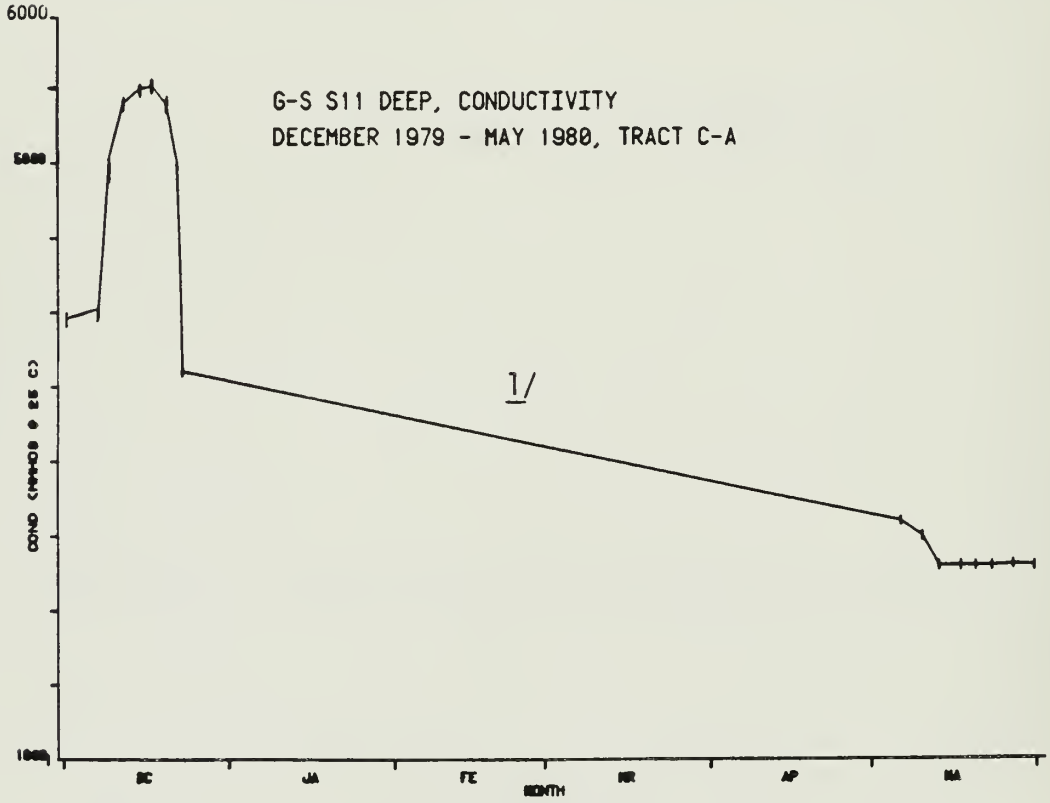

Figure 5-26. Conductivity at G-S S11 Deep, December 1979 - May 1980, Tract C-a

1/ Unable to be sampled

Plots of physical data for the West Retention Pond are shown in Figures 5-137 through 5-139. The conductivity was stable at 1400 micromhos; temperature fluctuations are attributed to the atmospheric effect of variations in temperatures; pH remained relatively constant at about 8.0 although towards the end of May, a rise occurred.

Physical data for East Retention Pond are plotted in Figures 5-140 through 5-142. All three parameters exhibited sudden changes that are attributed to pond turnover. Conductivity decreased radically in late January and then increased slightly in late April. Temperature and pH both changed at the same time, but inversely to conductivity.

Four piezometers were located downstream from the East and West Retention Ponds for the purpose of monitoring pond seepage. Water level observations were taken in each of the piezometers during the reporting period. Piezometers #2 and #3 were dry. Piezometers #1 and #4 sporadically contained water which is attributed to spring snowmelt and rainfall. The physical data for this water are shown in Figures 5-143 through 5-150.

c. Composite reinjection - Water was reinjected from the West Retention Pond into the upper aquifer through Wells No. G-S 4-5, G-S 6, and TO-3. Total reinjection is shown in Figure 5-151. Almost all of the water produced through April (an average of about 1500 gpm) was reinjected. In May reinjection capacity decreased about 300 gpm and surface discharge was necessary. Physical data for the water which was reinjected are shown in Figures 5-152 through 5-154. Conductivity and pH were almost identical to West Pond measurements. Temperature was very similar to West Pond measurements, but showed some difference in magnitude.

Miller Spring is monitored to measure the effects of reinjection. The hydrograph for Miller Spring is shown in Figure 5-155. Miller Spring has a very low flow rate, and the fluctuations on the hydrograph may be due to the level of precision of measurement, as well as actual fluctuations. A slight decrease in flow through the winter months with a slight increase in spring is

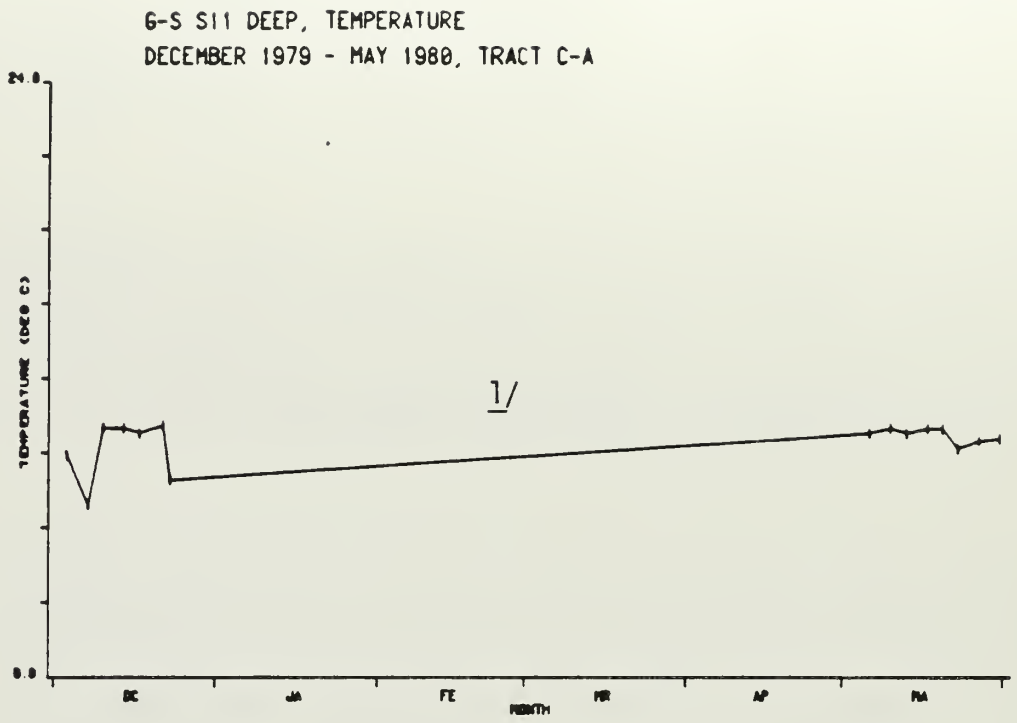

Figure 5-27. Temperature at G-S S11 Deep, December 1979 - May 1980, Tract C-a

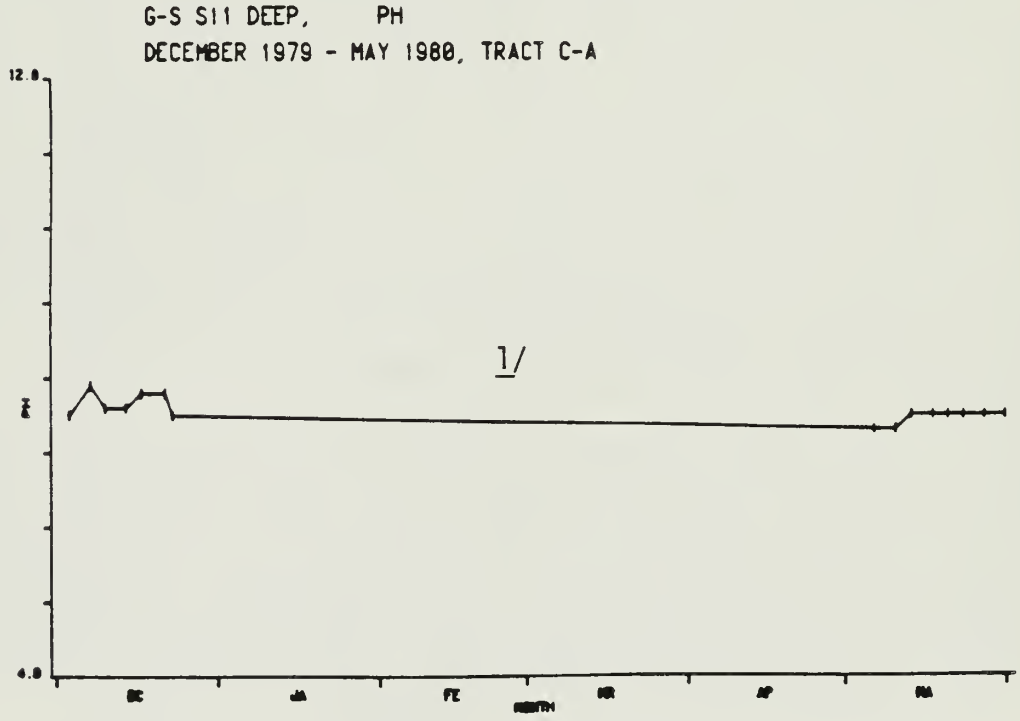

Figure 5-28. pH at G-S S11 Deep, December 1979 - May 1980, Tract C-a

1/ Unable to be sampled

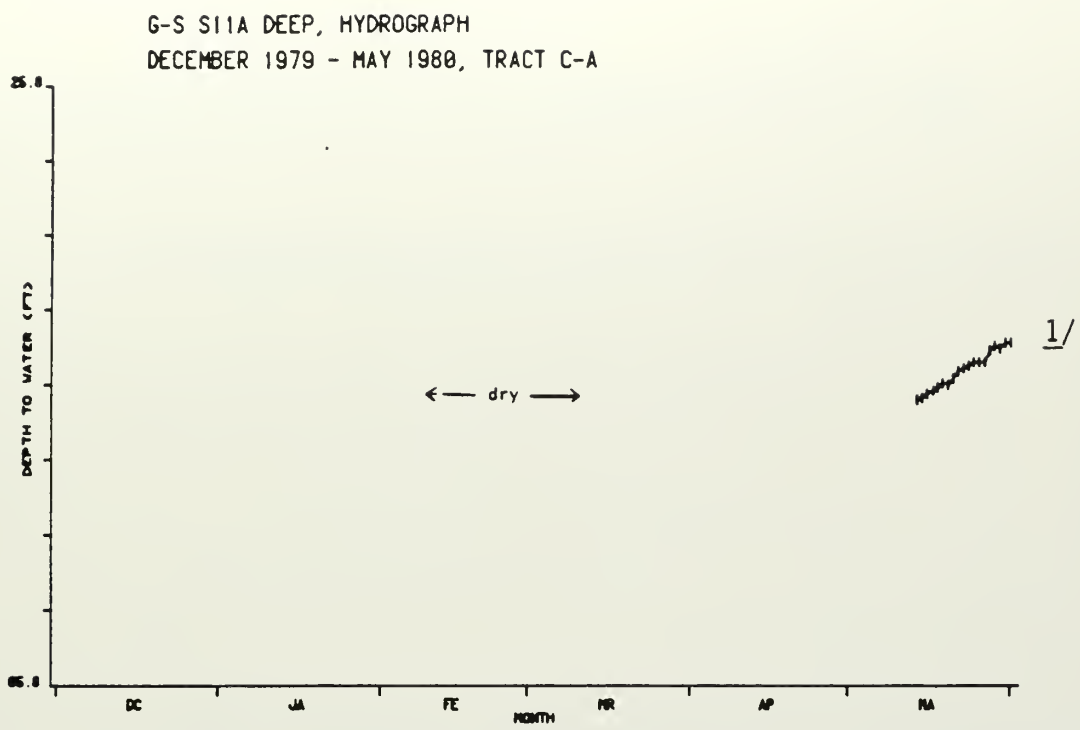

Figure 5-29. Hydrograph of G-S S11A Deep, December 1979 - May 1980, Tract C-a

1/ Unable to be sampled.

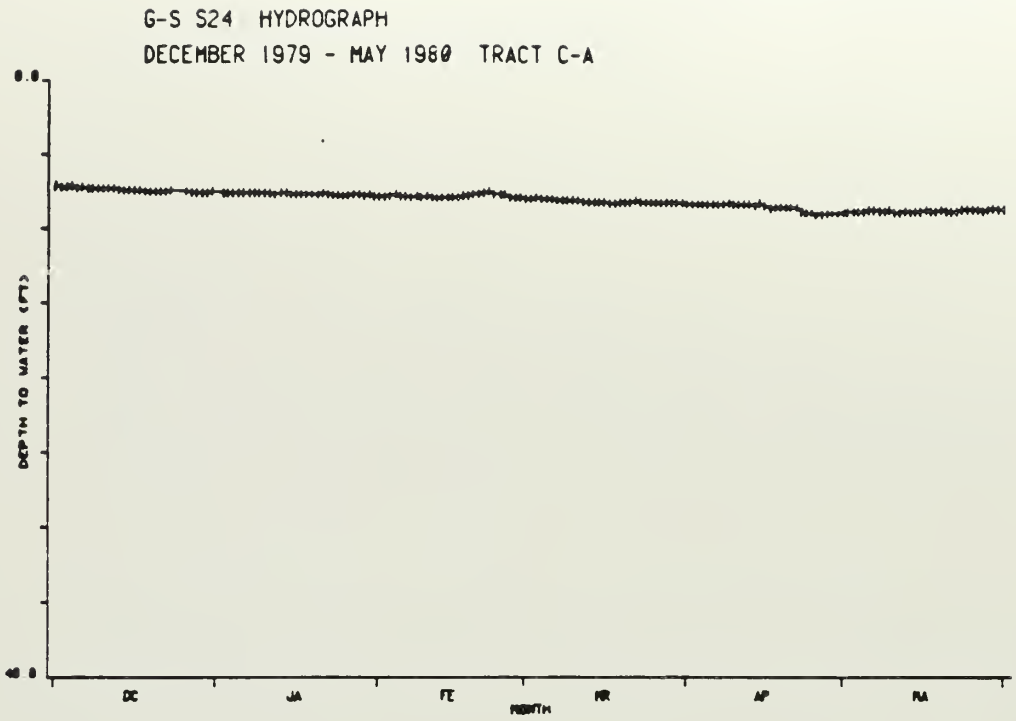

Figure 5-30. Hydrograph of G-S S24, December 1979 - May 1980, Tract C-a

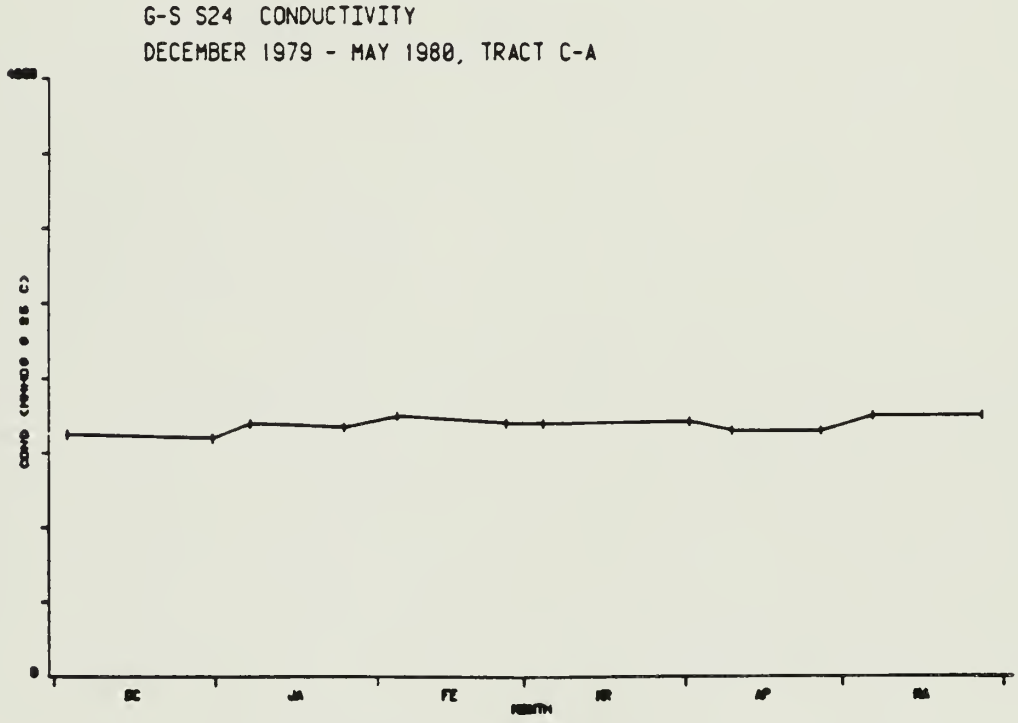

Figure 5-31. Conductivity at G-S S24, December 1979 - May 1980, Tract C-a

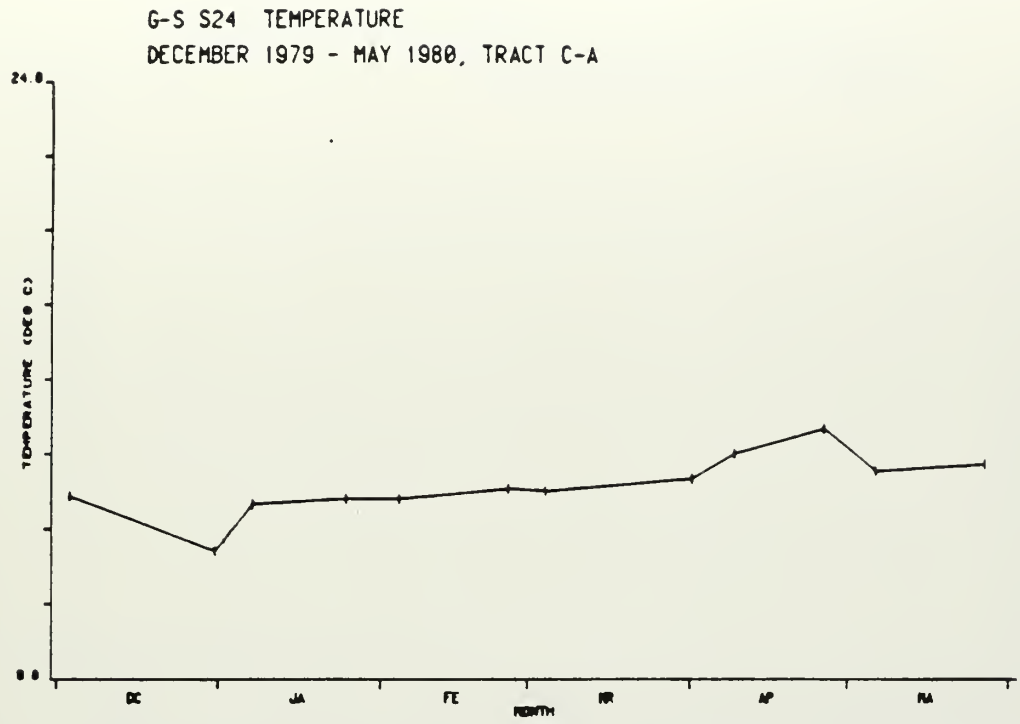

Figure 5-32. Temperature at G-S S24, December 1979 - May 1980, Tract C-a

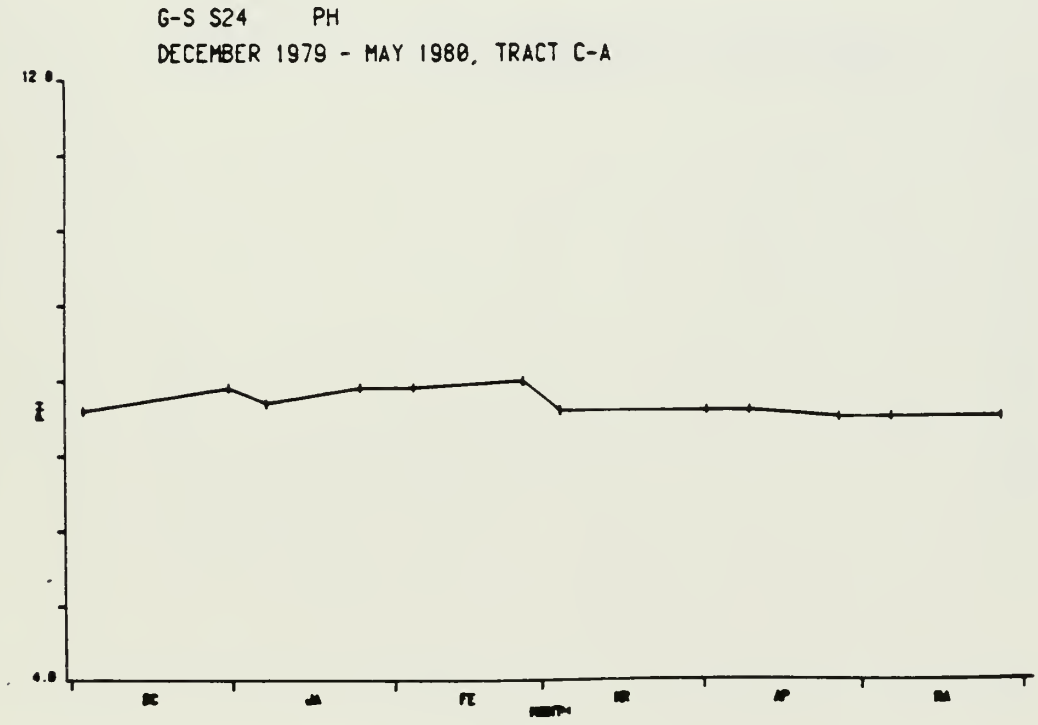

Figure 5-33. pH at G-S S24, December 1979 - May 1980, Tract C-a

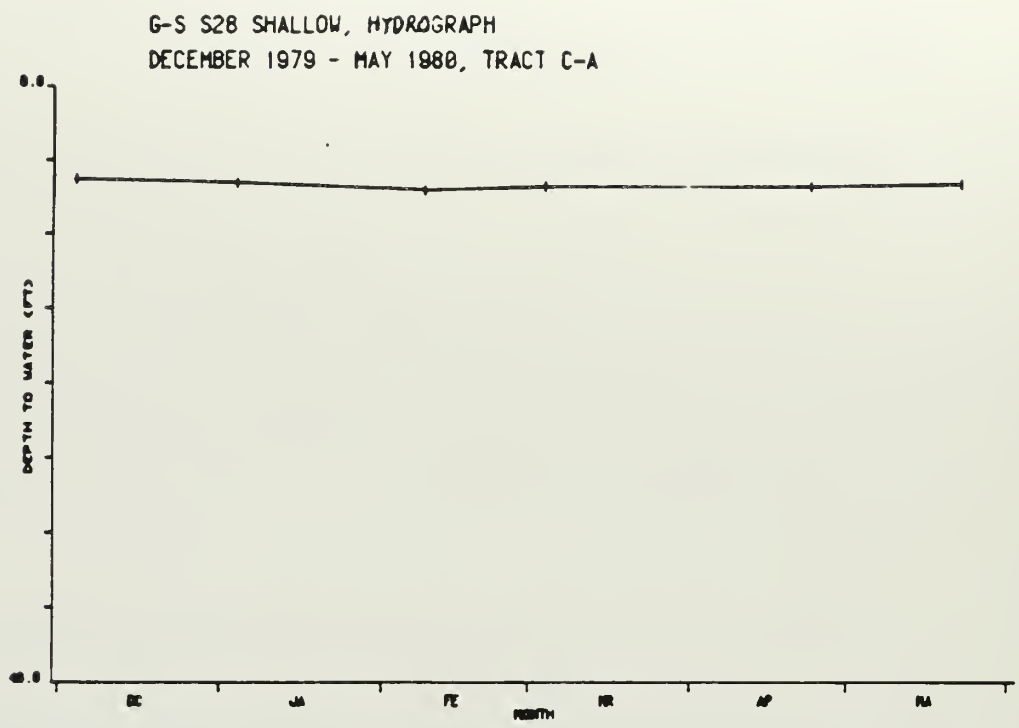

Figure 5-34. Hydrograph of G-S S28 Shallow, December 1979 - May 1980, Tract C-a

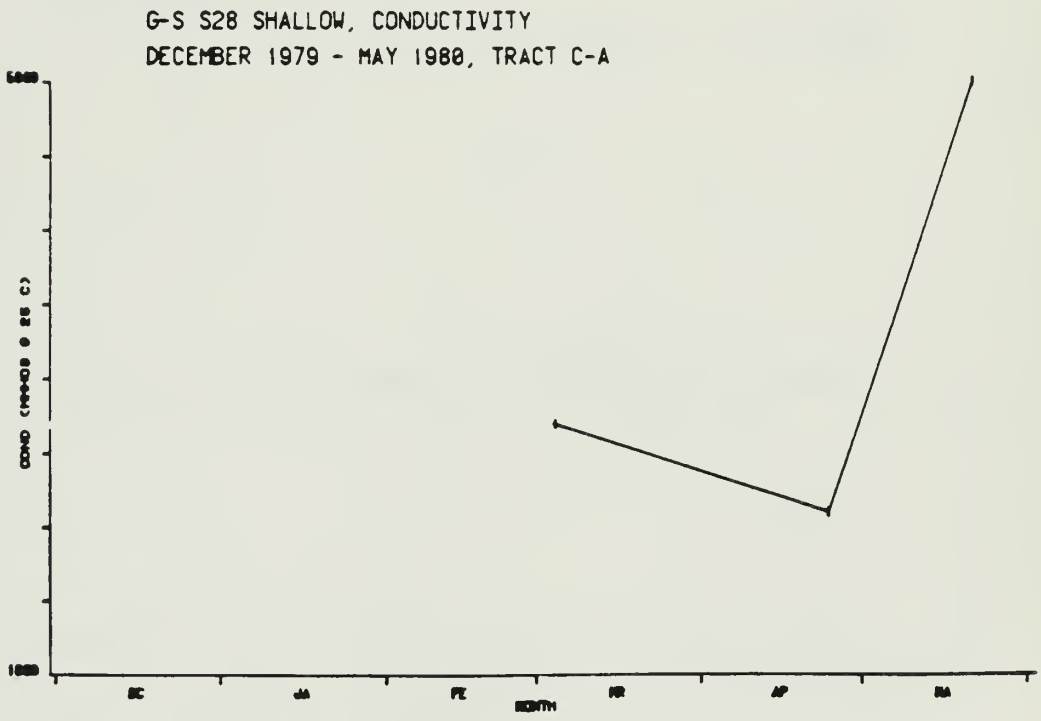

Figure 5-35. Conductivity at G-S S28 Shallow, December 1979 - May 1980, Tract C-a

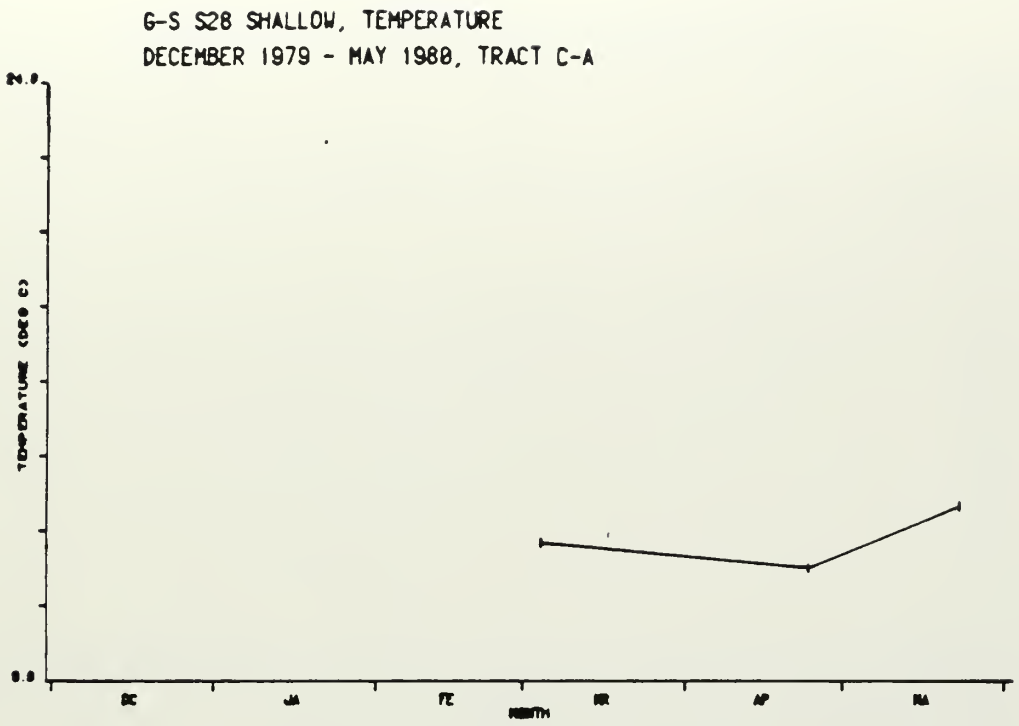

Figure 5-36. Temperature at G-S S28 Shallow, December 1979 - May 1980, Tract C-a

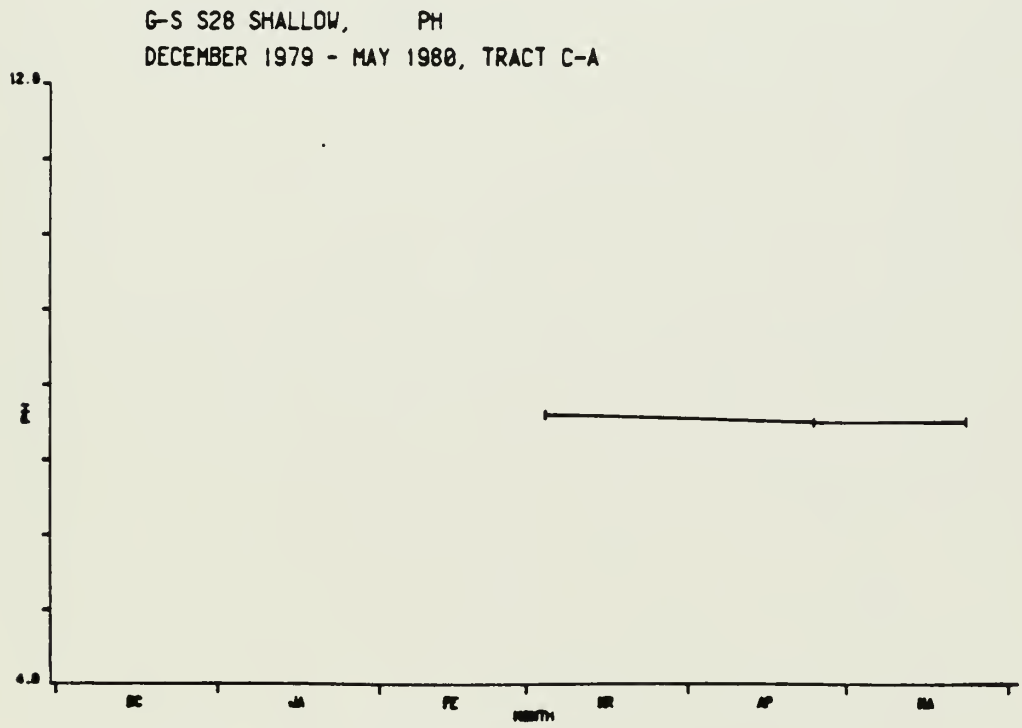

Figure 5-37. pH at G-S S28 Shallow, December 1979 - May 1980, Tract C-a

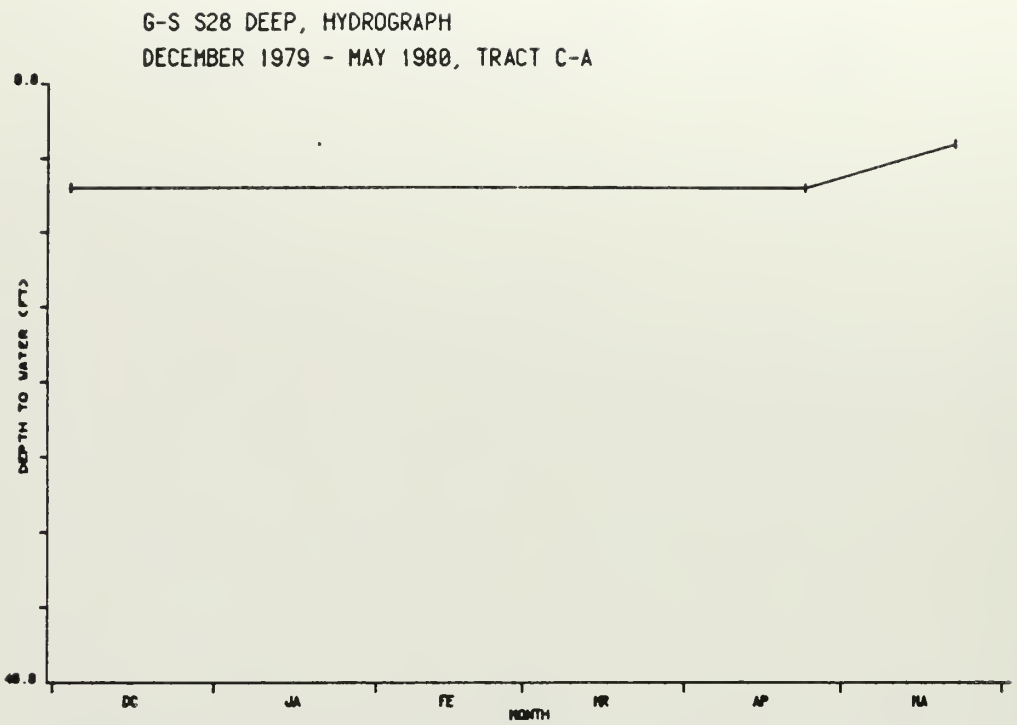

Figure 5-38. Hydrograph of G-S S28 Deep, December 1979 - May 1980, Tract C-a

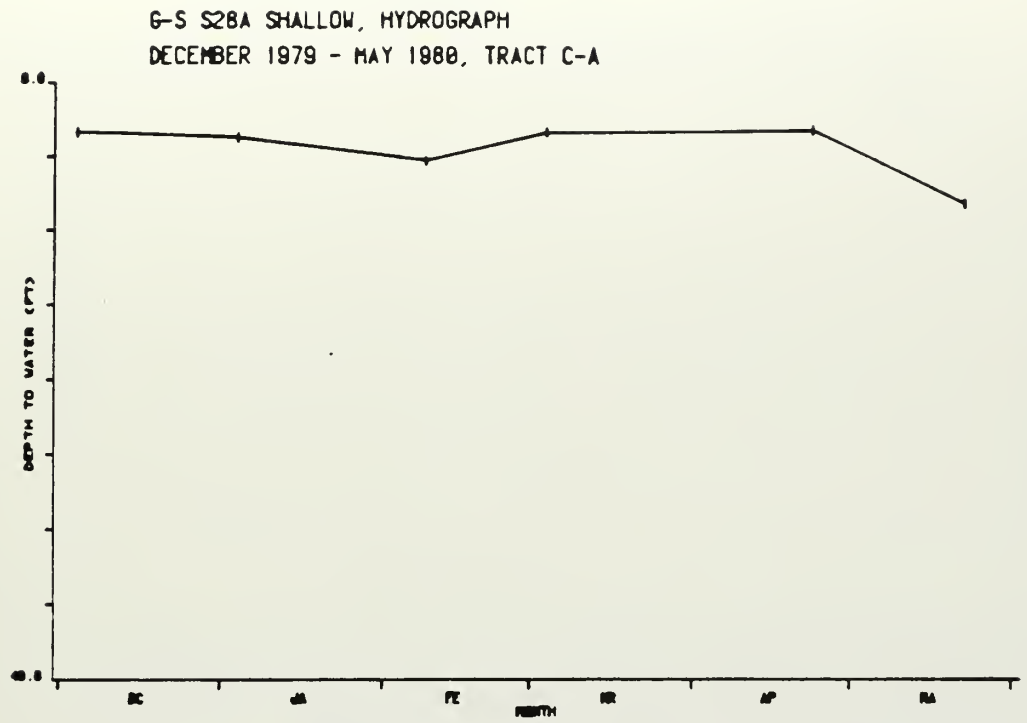

Figure 5-39. Hydrograph of G-S S28A Shallow, December 1979 - May 1980, Tract C-a

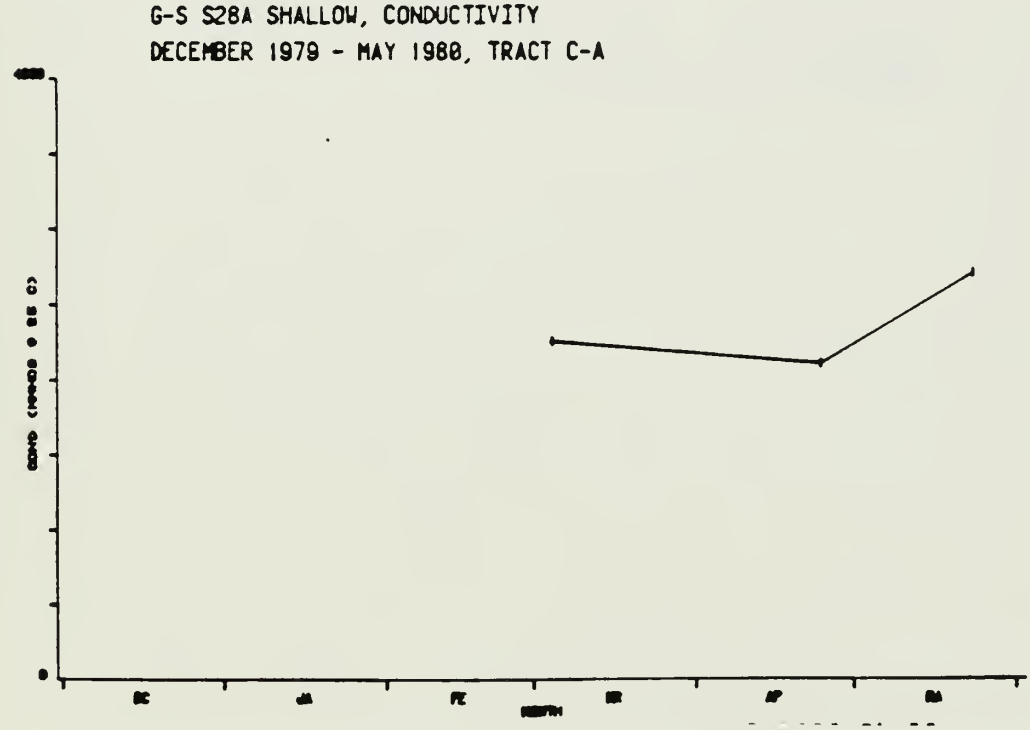

Figure 5-40. Conductivity at G-S S28A Shallow, December 1979 - May 1980, Tract C-a

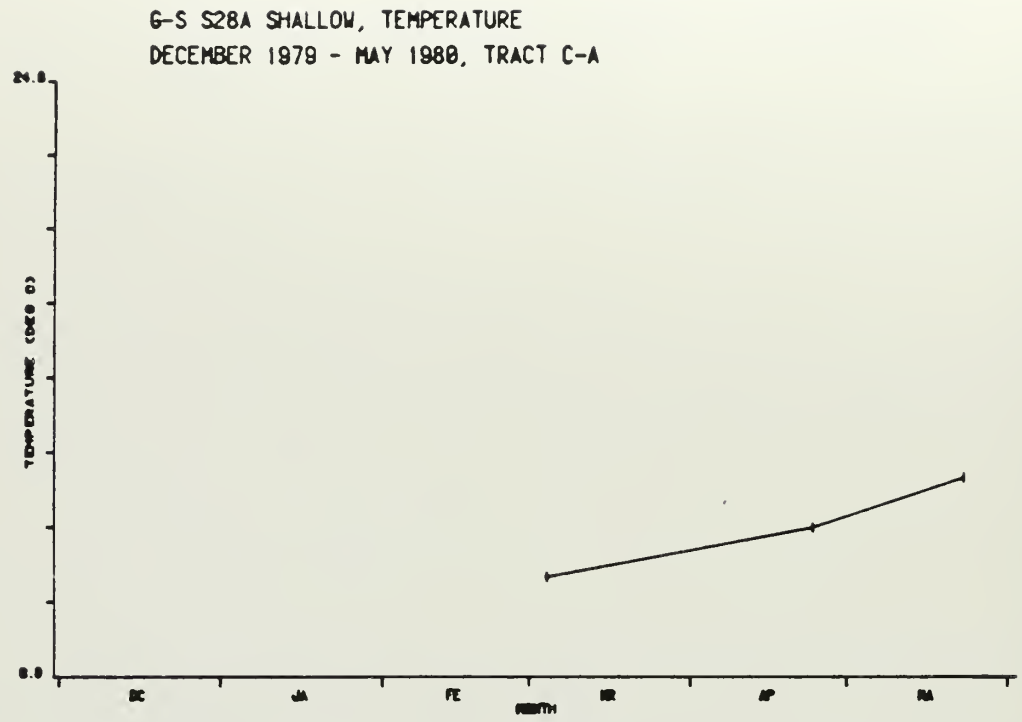

Figure 5-41. Temperature at G-S S28A Shallow, December 1979 - May 1980, Tract C-a

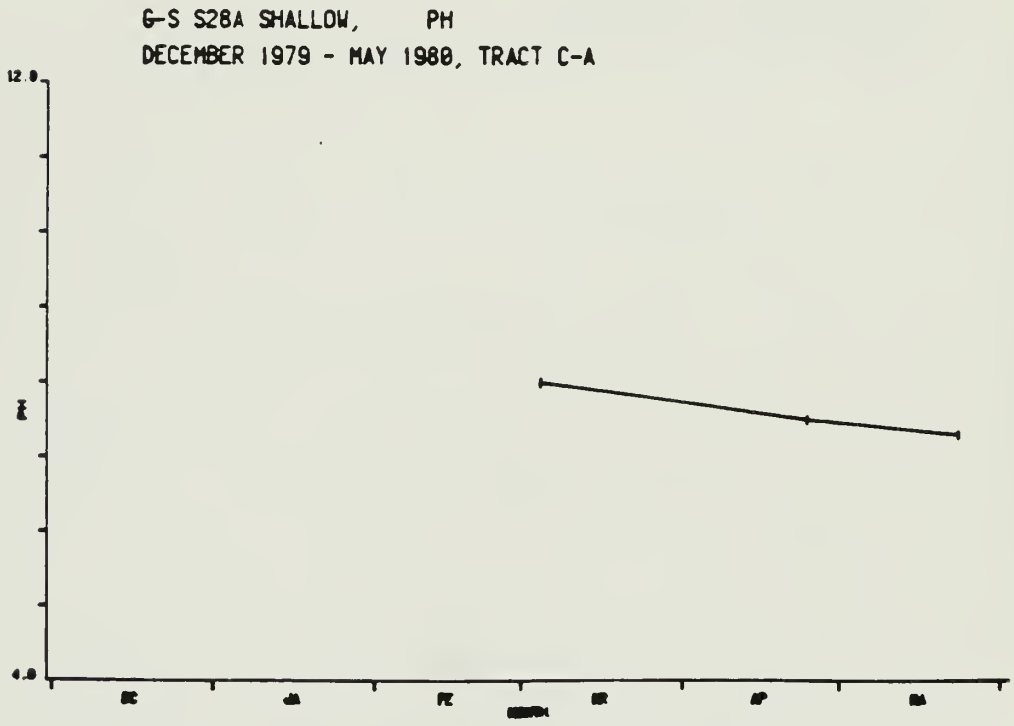

Figure 5-42. pH at G-S S28A Shallow, December 1979 - May 1980, Tract C-a

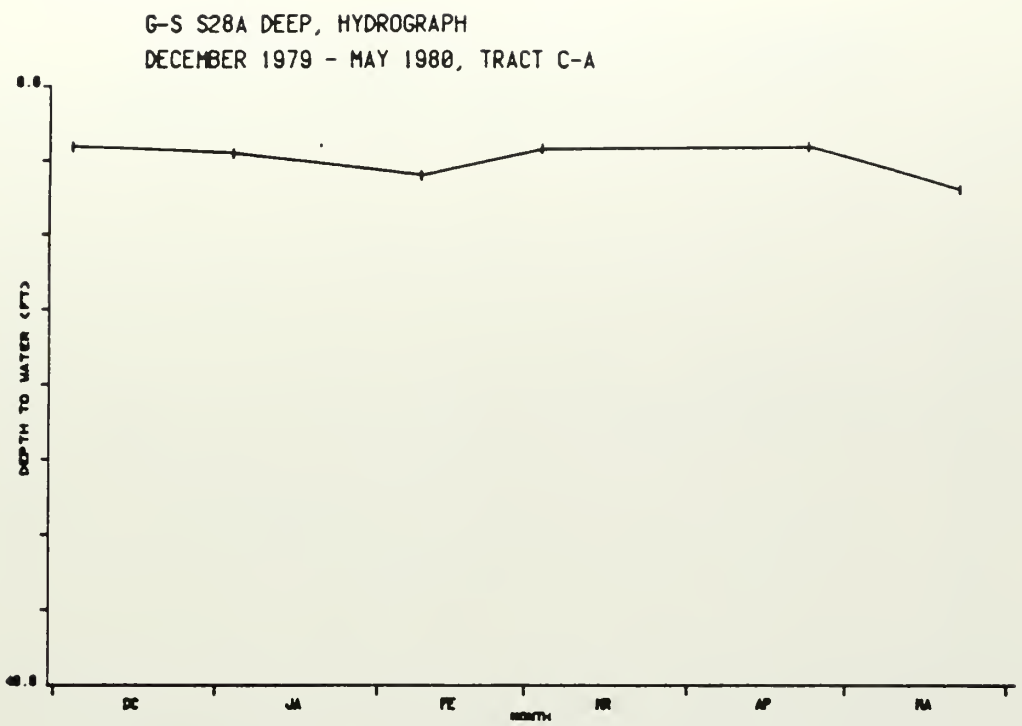

Figure 5-43. Hydrograph of G-S S28A Deep, December 1979 - May 1980, Tract C-a

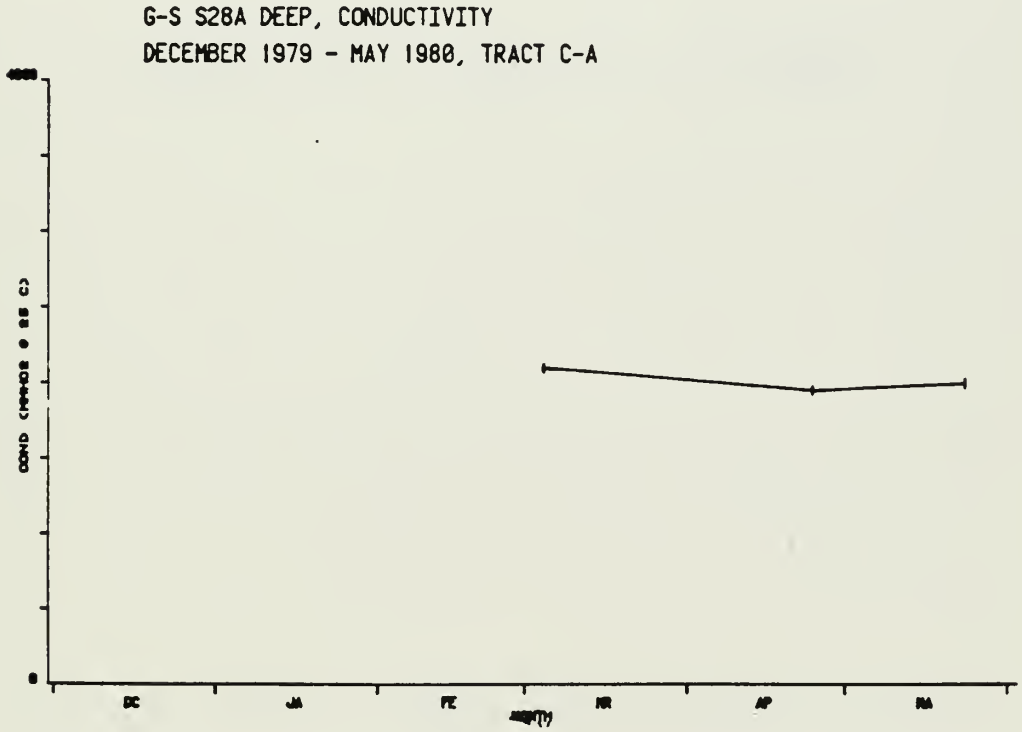

Figure 5-44. Conductivity at G-S S28A Deep, December 1979 - May 1980, Tract C-a

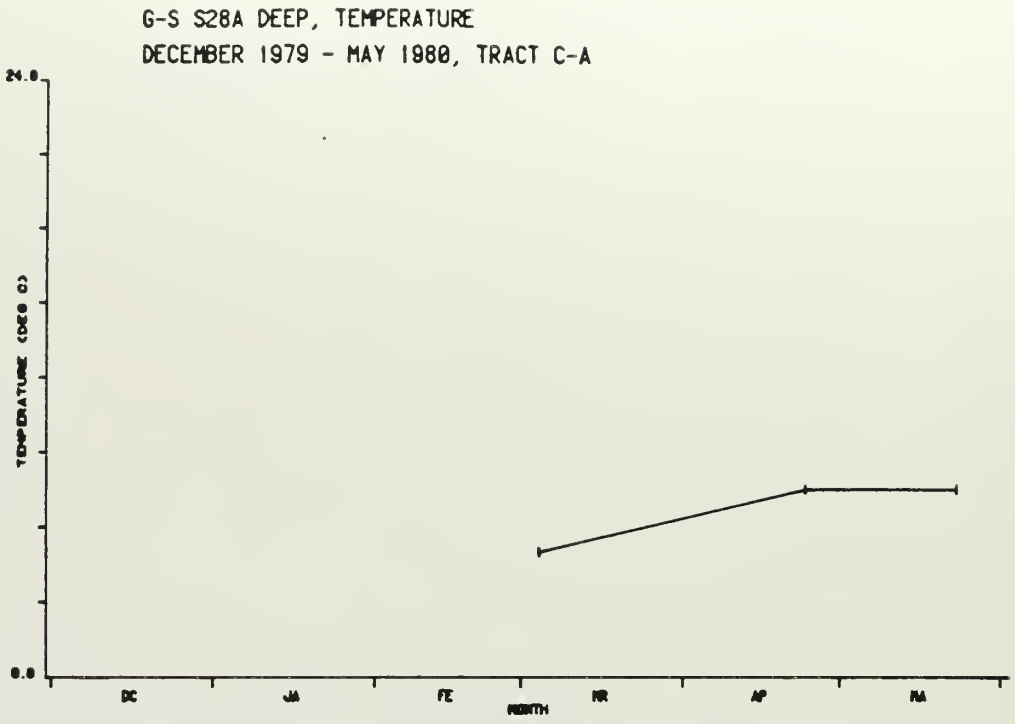

Figure 5-45. Temperature at G-S S28A Deep, December 1979 - May 1980, Tract C-a.

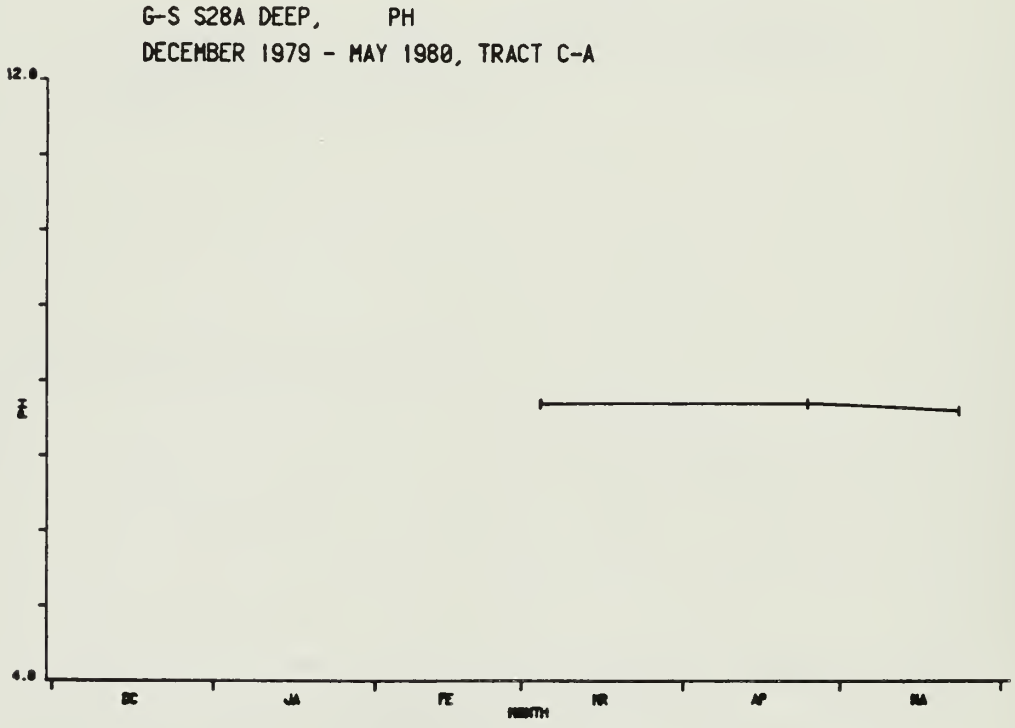

Figure 5-46. pH at G-S S28A Deep, December 1979 - May 1980, Tract C-a

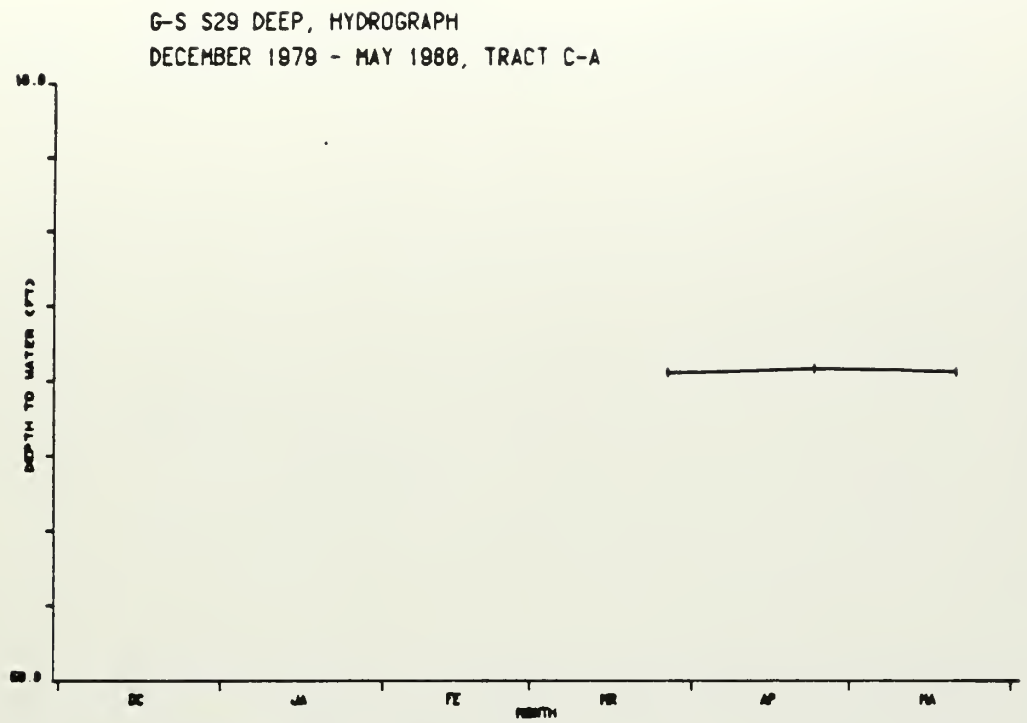

Figure 5-47. Hydrograph of G-S S29 Deep, December 1979 - May 1980, Tract C-a

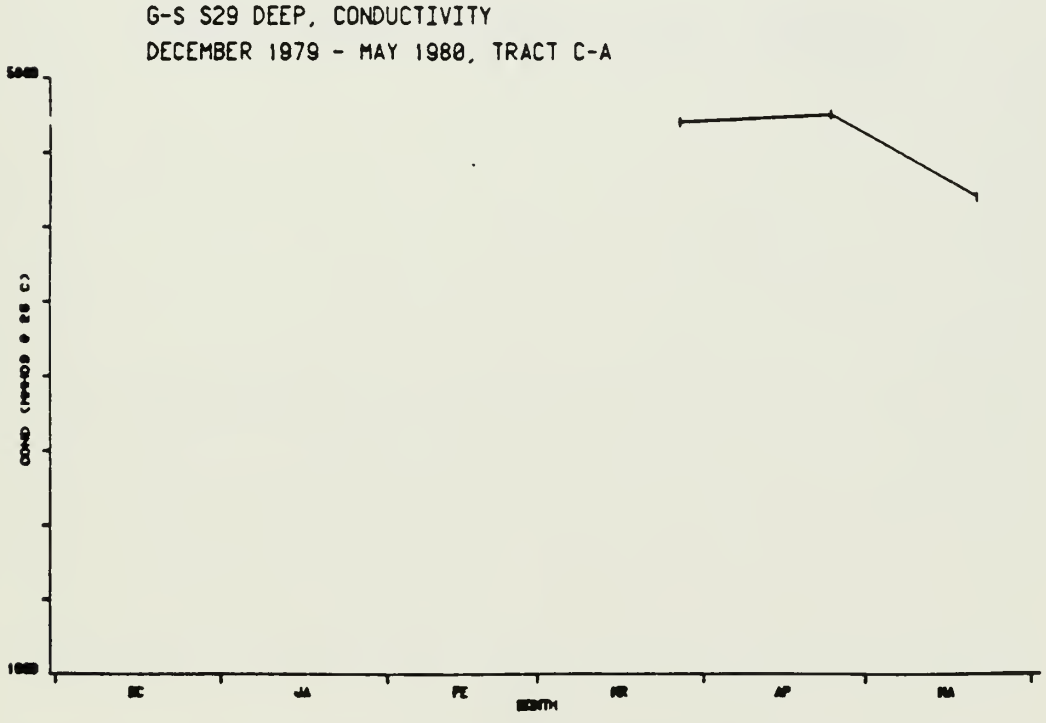

Figure 5-48. Conductivity at G-S S29 Deep, December 1979 - May 1980, Tract C-a

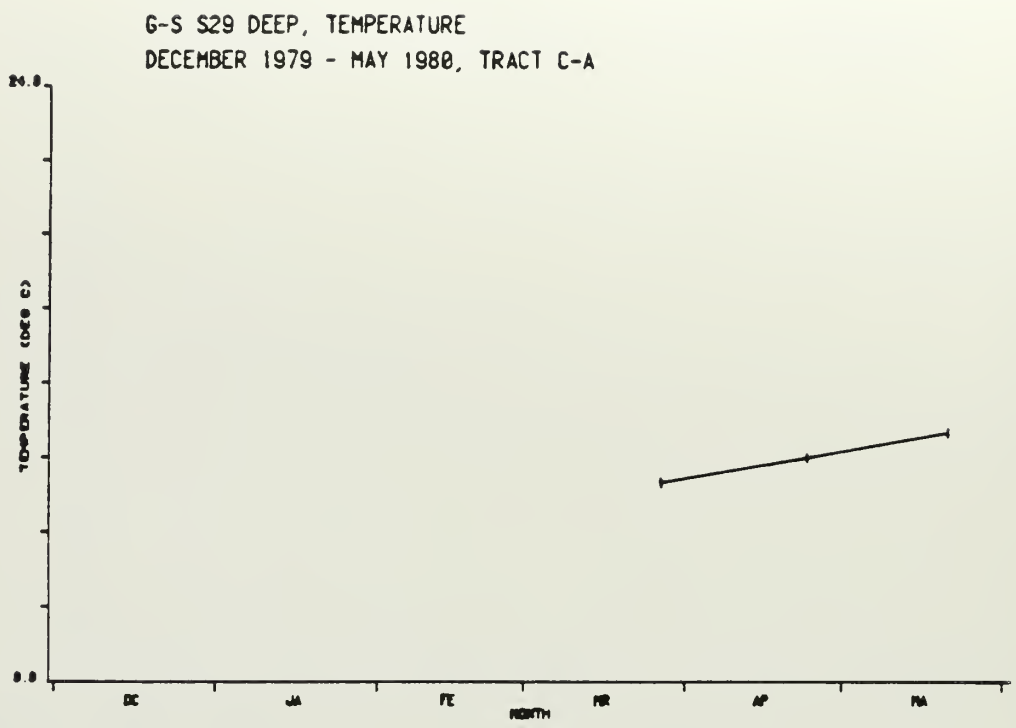

Figure 5-49. Temperature at G-S S29 Deep, December 1979 - May 1980, Tract C-a

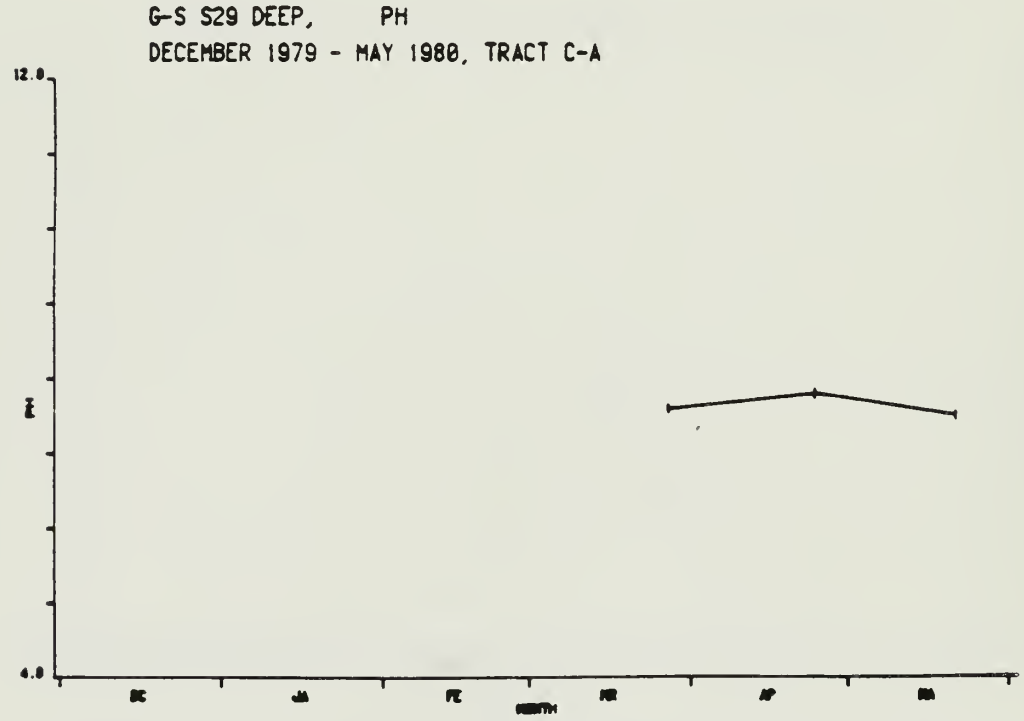

Figure 5-50. pH at G-S S29 Deep, December 1979 - May 1980, Tract C-a

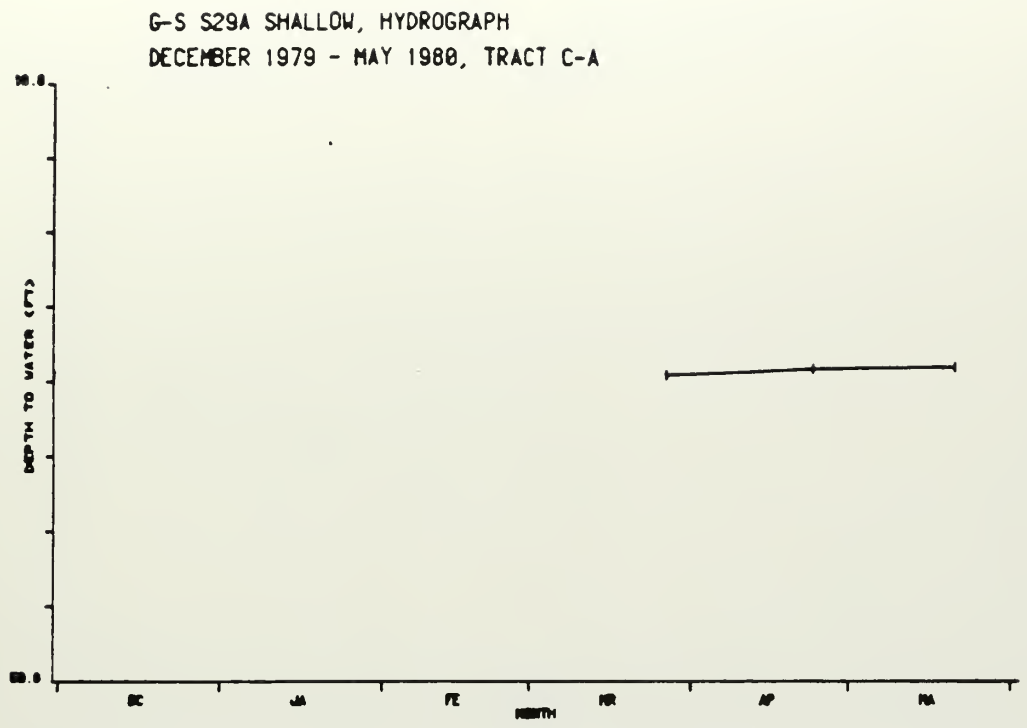

Figure 5-51. Hydrograph of G-S S20A Shallow, December 1979 - May 1980, Tract C-a

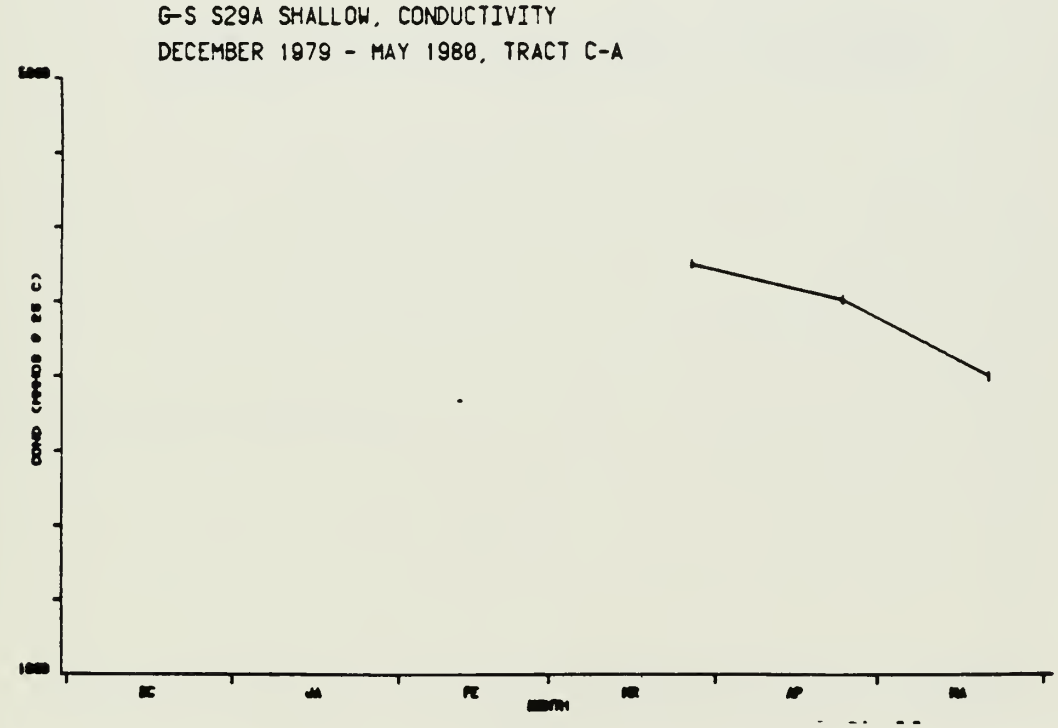

Figure 5-52. Conductivity at G-S S29A Shallow, December 1979 - May 1980, Tract C-a

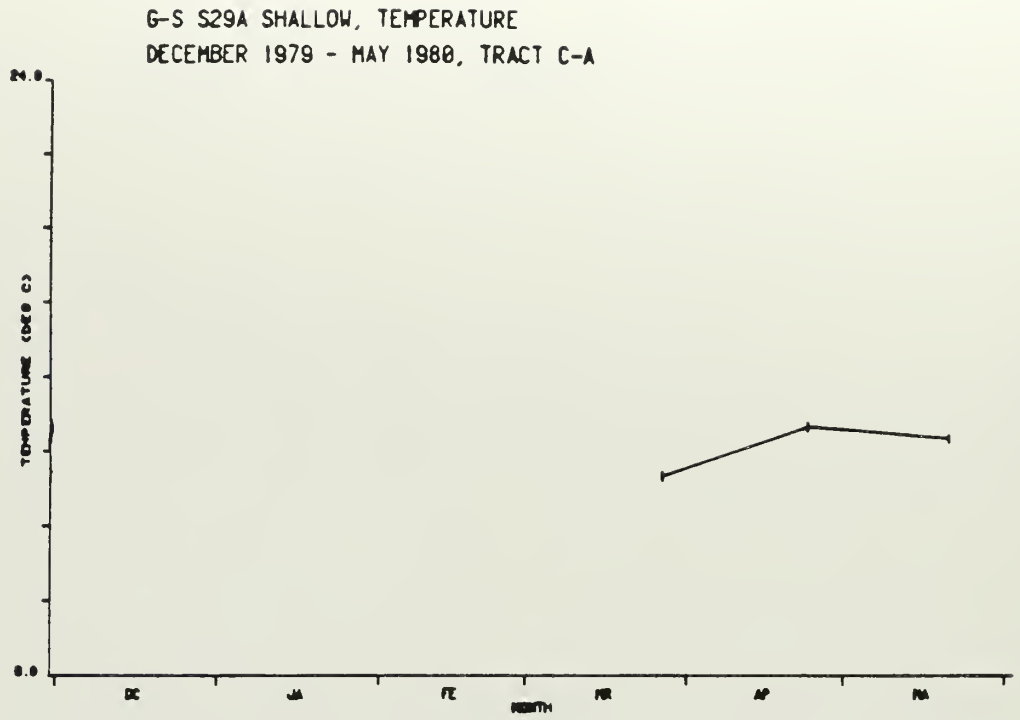

Figure 5-53. Temperature at G-S S29A Shallow, December 1979 - May 1980, Tract C-a

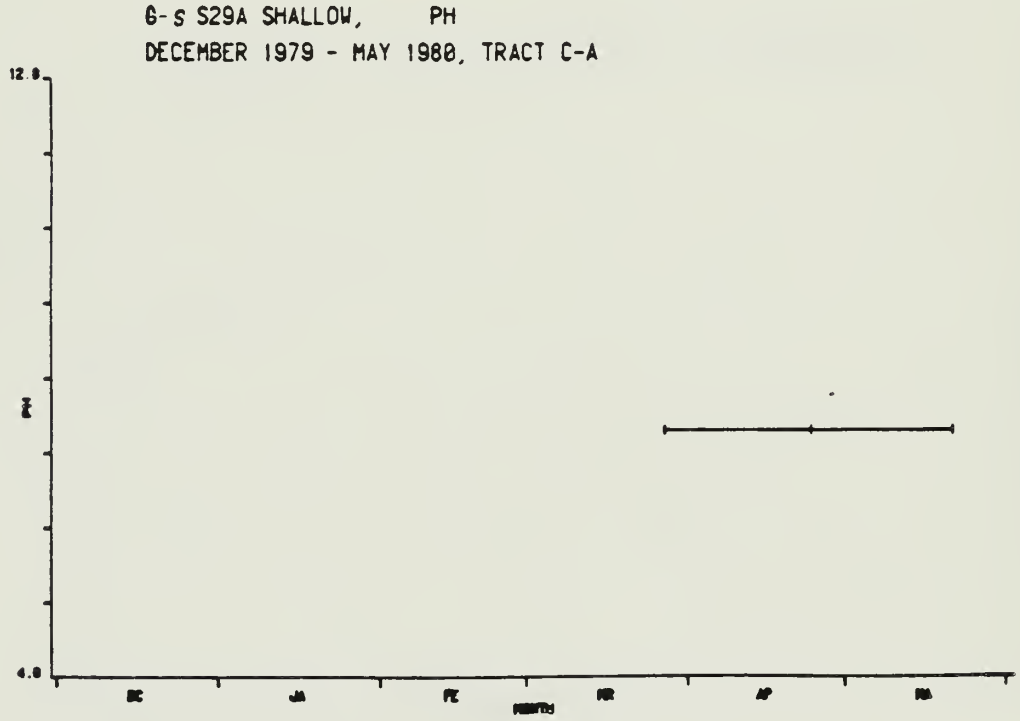

Figure 5-54. pH at G-S S29A Shallow, December 1979 - May 1980, Tract C-a

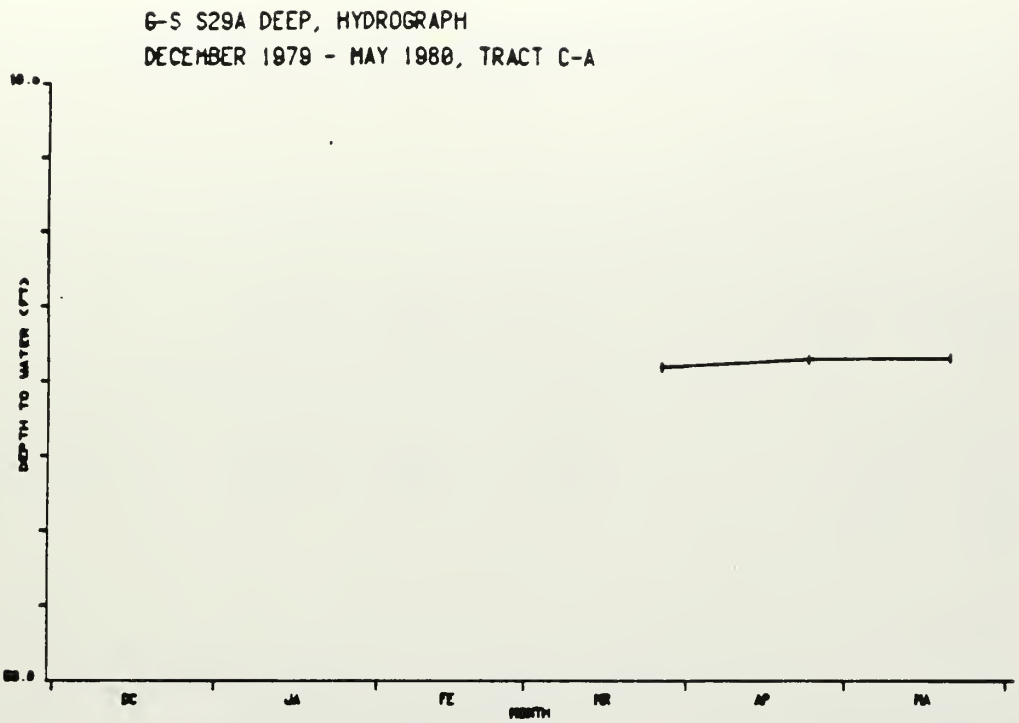

Figure 5-55. Hydrograph of G-S S29A Deep, December 1979 - May 1980, Tract C-a

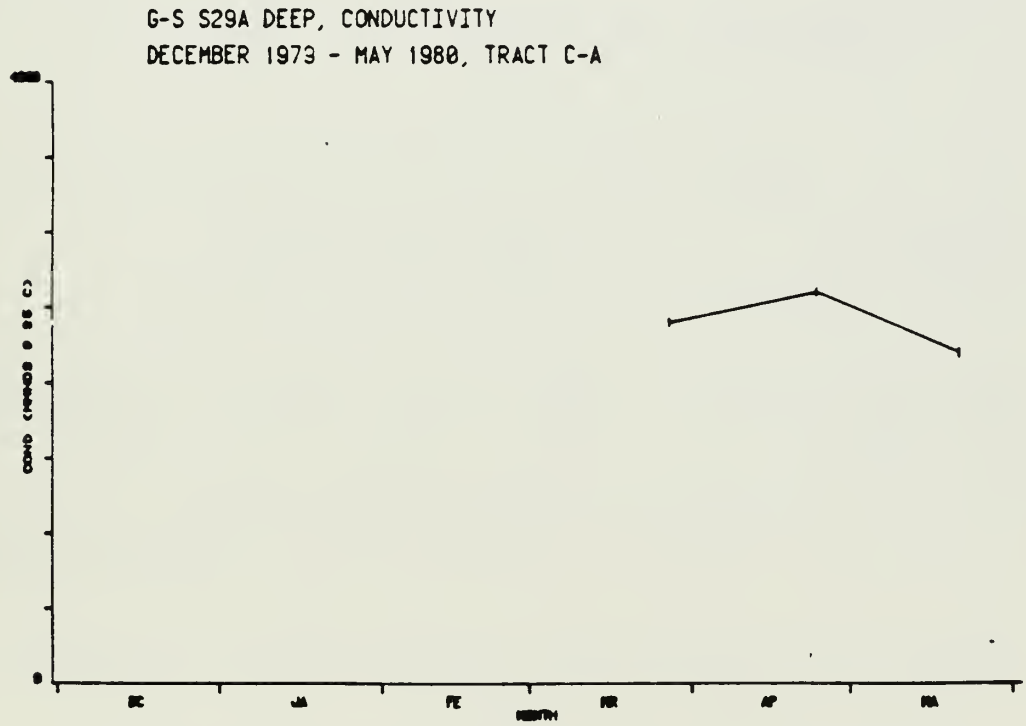

Figure 5-56. Conductivity at G-S S29A Deep, December 1979 - May 1980, Tract C-a

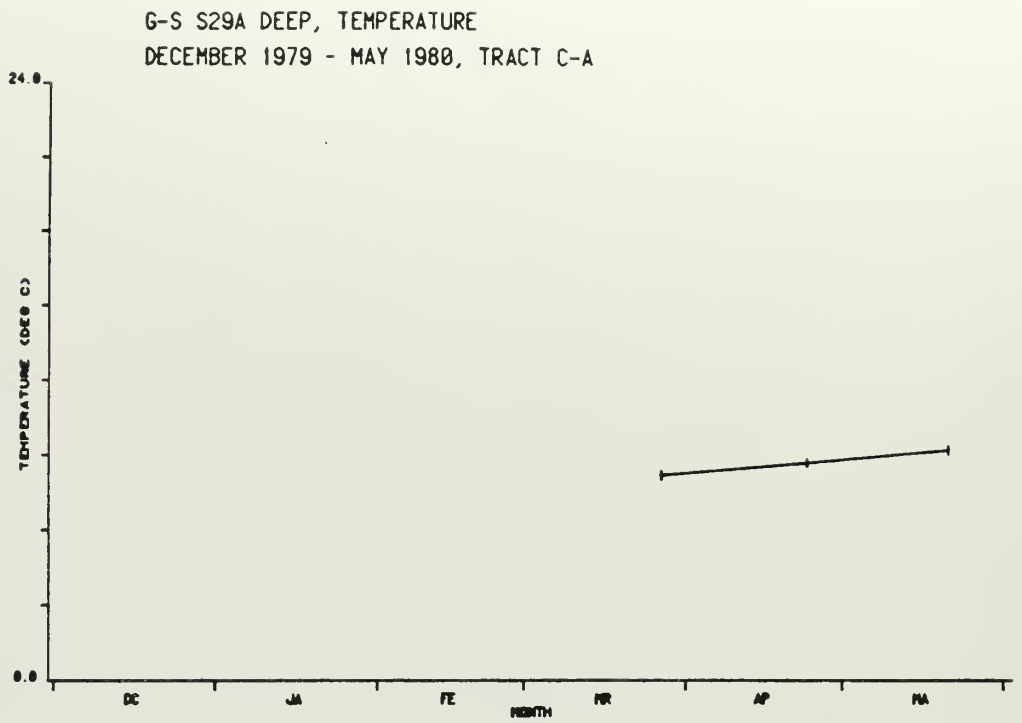

Figure 5-57. Temperature at G-S S29A Deep, December 1979 - May 1980, Tract C-a

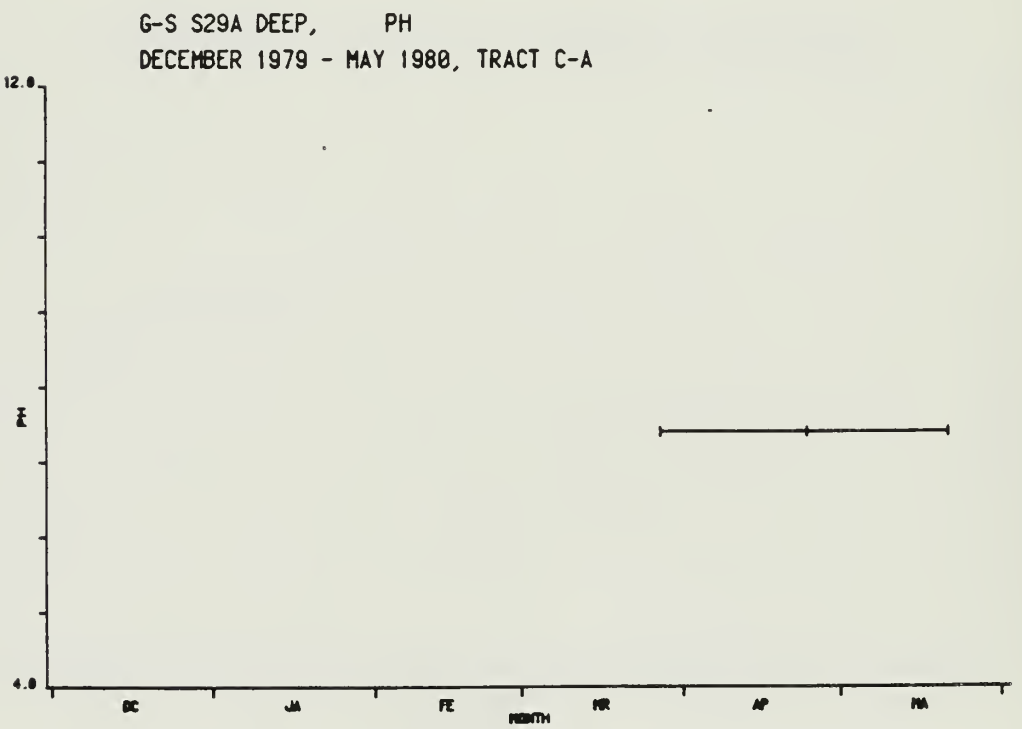

Figure 5-58. pH at G-S S29A Deep, December 1979 - May 1980, Tract C-a

Table 5-8 Comparison of Baseline Data with Subsequent Yearly Data from Alluvial Monitoring Holes, Tract C-a

G-S S7

	Baseline 1975-1976			Average Values[1]			
	Min.	Max	Mean	1977	1978	1979	1980
Water Level (feet)			21.6	27.6	28.0	25.2	23.2
Temperature (°C)	6.11	11.3	9.2	6.2	9.0	10.3	9.0
Conductivity (umhos)	990	1440	1096	1220	1218	1138	1277
pH				8.0	7.2	7.8	7.5

G-S S8

	Baseline 1975-1976			Average Values[1]			
	Min.	Max	Mean	1977	1978	1979	1980[2]
Water Level (feet)			35.7	41.1	37.6	36.8	35.8
Temperature (°C)	7.89	14.0	9.6	8.0	8.8	8.8	9.0
Conductivity (umhos)	860	1150	970	990	1034	1112	1000
pH				8.1	7.6	7.3	7.1

G-S S11 Deep

	Baseline 1975-1976			Average Values[1]			
	Min.	Max	Mean	1977	1978	1979	1980
Water Level (feet)			44.0	47.0	46.4	35.7	37.5
Temperature (°C)	8.8	13.5	10.3	5.8	9.6	9.2	9.4
Conductivity (umhos)	1560	2220	1796	1990	1799	2324	3300
pH				8.0	7.1	7.6	7.6

1/ Averaged from daily and weekly samples
2/ Single measurement

G-S S11 and G-S S11A are located in the Corral Gulch alluvium two miles downstream from the east tract boundary. Both wells are dual completions with shallow and deep zones being monitored. G-S S11 shallow was dry from December through April. G-S S11A was dry during the reporting period. G-S S11 deep contained water throughout the reporting period except for a short dry spell during late February and early March but was too shallow to sample. Water levels rose at this site in May. The physical data are shown in Figures 5-24 through 5-29. Temperature and pH appear to have remained relatively stable, but conductivity values peaked in December and have returned to baseline values. During MDP the physical data at G-S S11 has fluctuated as shown in Table 5-8.

G-S S24 is located in the Corral Gulch alluvium about three miles downstream from the east tract boundary. The physical data are plotted in Figures 5-30 through 5-33. The water level did not respond to any influence as is displayed by the steady hydrograph. The conductivity, temperature and pH fluctuated somewhat.

Shallow and deep holes at G-S S28 and G-S S28A, G-S S29 and G-S S29A are located in Yellow Creek alluvium approximately six and one-half miles downstream from the eastern tract boundary. Monitoring of these wells began this reporting period. The physical data are plotted in Figures 5-34 through 5-58. The data indicates that the water levels in the alluvium have remained relatively stable during the reporting period. Conductivity fluctuated but temperature and pH showed little variation.

b. Chemical parameters - Water quality analyses of alluvial wells are located in Appendix 5-2.1.

B. Deep Oil Shale Aquifers (Upper and Lower)

1. Objectives

Deep (upper and lower) oil shale aquifers are being monitored during the modular development phase for water level and water quality. These data are analyzed and compared with data collected during the baseline period for the purpose of detecting changes in the aquifer due to oil shale development activities. In addition, the objective of the monitoring program is to determine if lease and permit requirements, and applicable laws and regulations are being met.

2. Methods

a. Upper aquifer holes - Water levels are monitored daily in the upper aquifer in 14 boreholes, and weekly in 11 other boreholes (see Map 1, MDP Report 4). Water quality samples are collected monthly at 10 holes and analyzed for pH, conductivity, temperature, alkalinity, and major ions. Quarterly sampling is done in three of these holes for pH, conductivity, temperature, alkalinity, and major constituents. Semi-annual water quality samples are collected in January and July at 14 holes and analyzed for all constituents listed in the extensive program (Table 5-3).

b. Lower aquifer holes - Water levels are measured daily in one hole and weekly in five other holes. Quarterly water quality samples are collected and analyzed for pH, conductivity, temperature, alkalinity, and major constituents. During April and October, the water quality samples for the one hole are analyzed for the complete list of constituents presented in Table 5-3. During April the water quality samples for the other five holes are analyzed for the complete list of constituents presented in Table 5-3.

3. Results and Discussion

a. Physical parameters - The physical data which were obtained from the deep oil shale aquifer during this reporting period are presented in alphabetical order for the upper and lower aquifer, respectively in Figures 5-59 through 5-126.

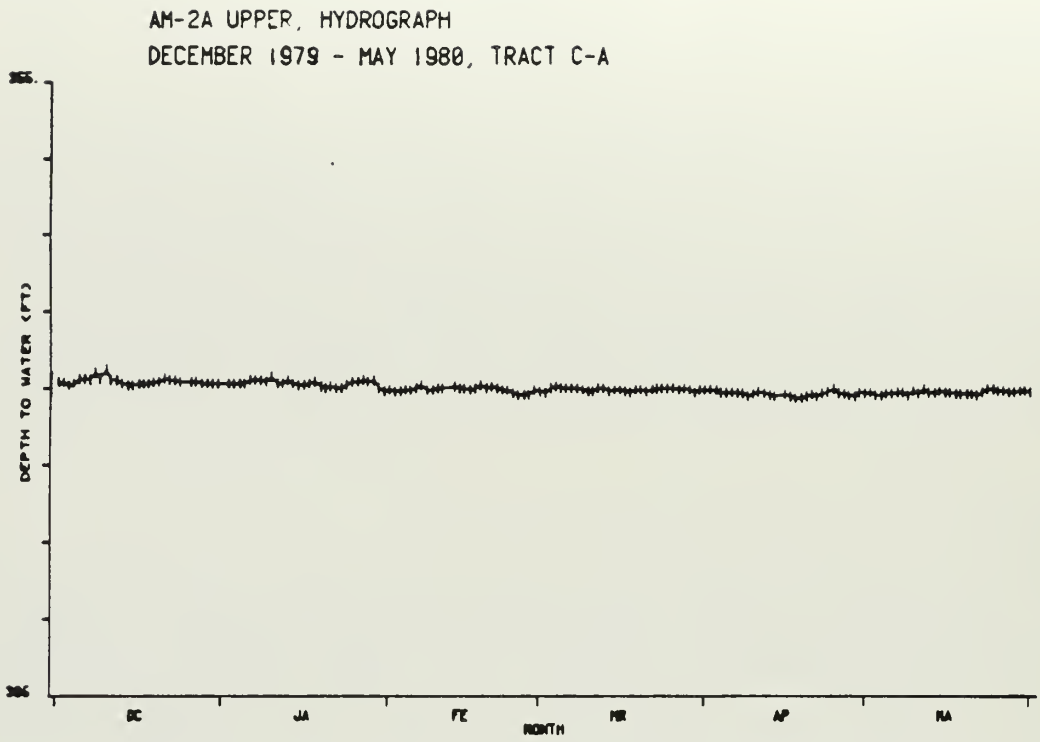

Figure 5-59. Hydrograph of AM-2A Upper, December 1979 - May 1980, Tract C-a

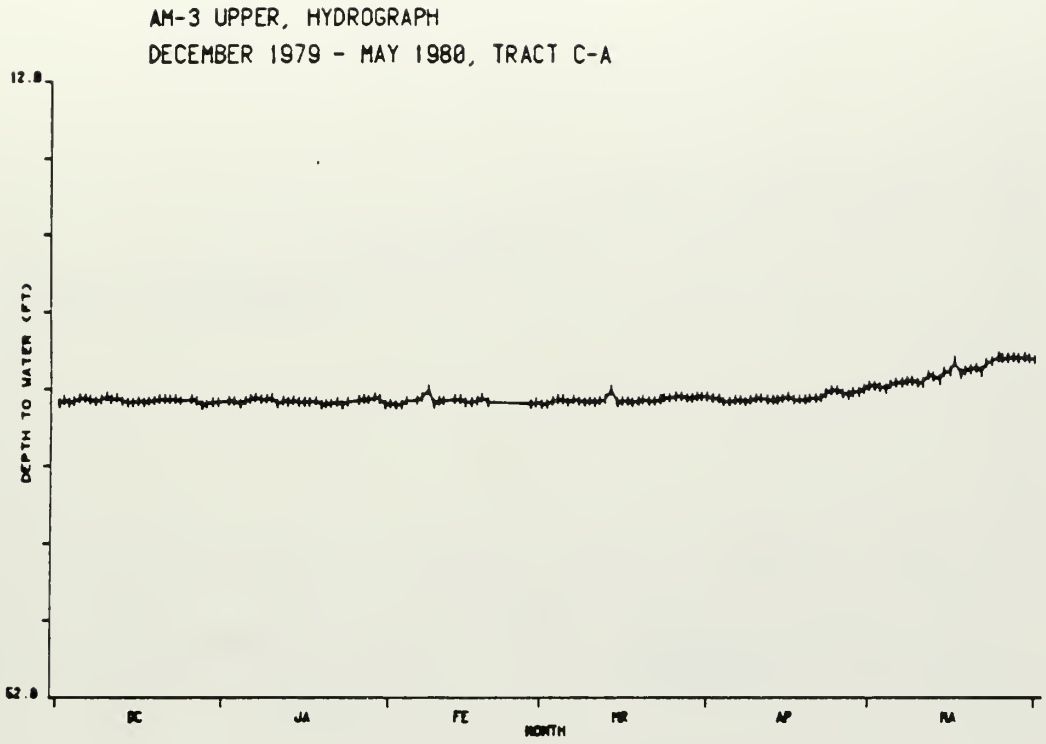

Figure 5-60. Hydrograph of AM-3 Upper, December 1979 - May 1980, Tract C-a

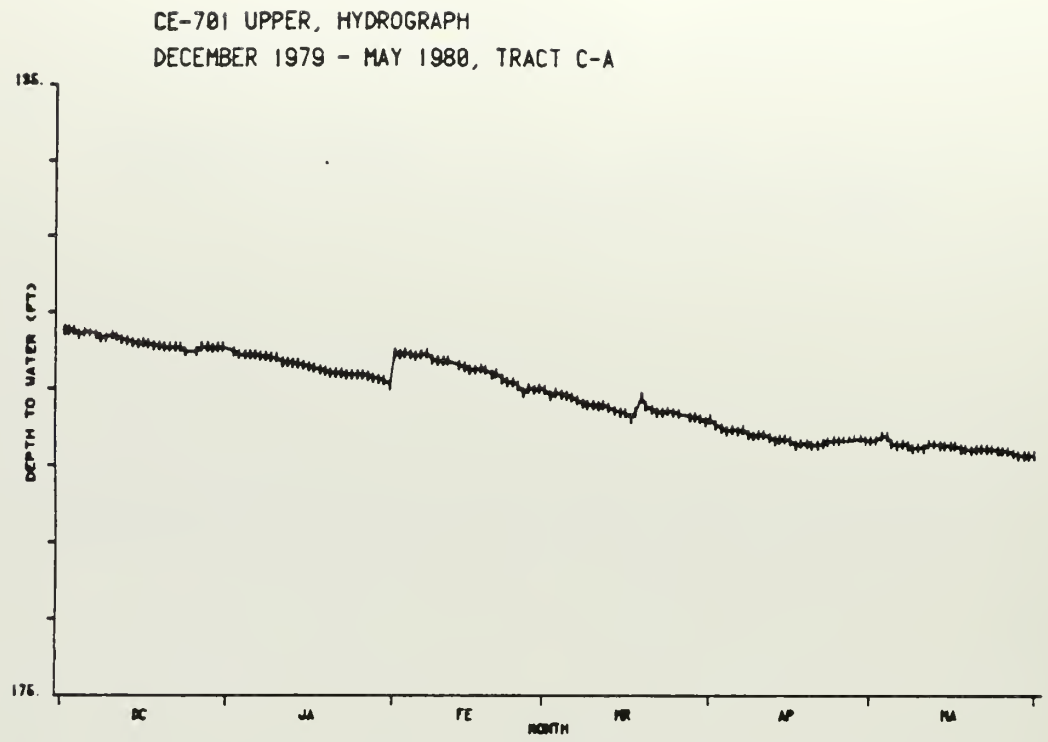

Figure 5-61. Hydrograph of CE-701 Upper, December 1979 - May 1980, Tract C-a

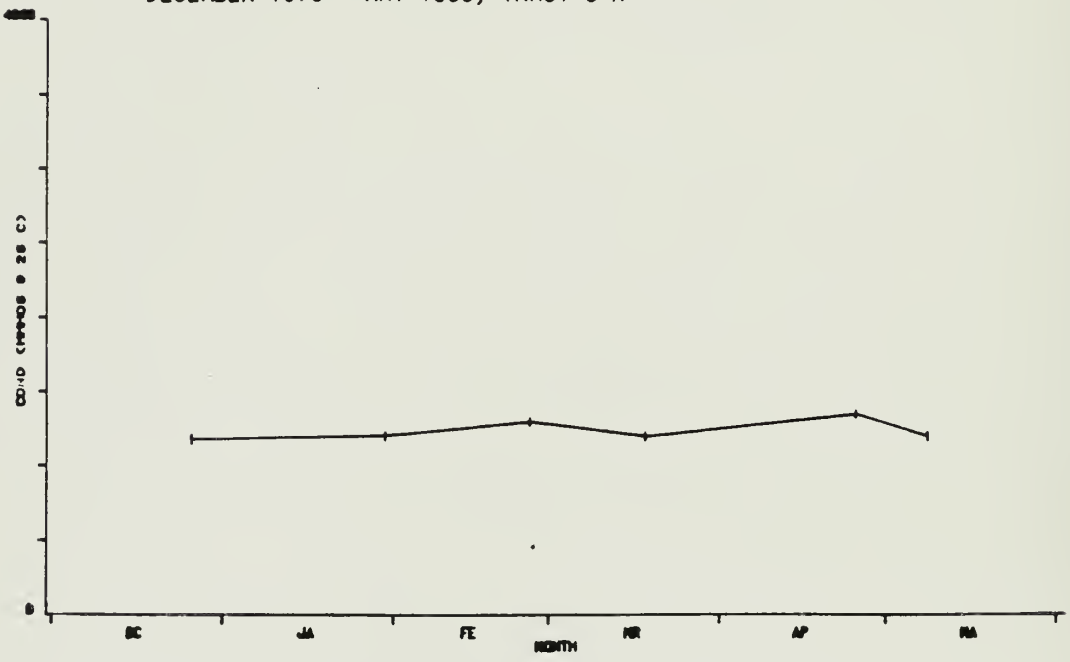

Figure 5-62. Conductivity at CE-701 Upper, December 1979 - May 1980, Tract C-a

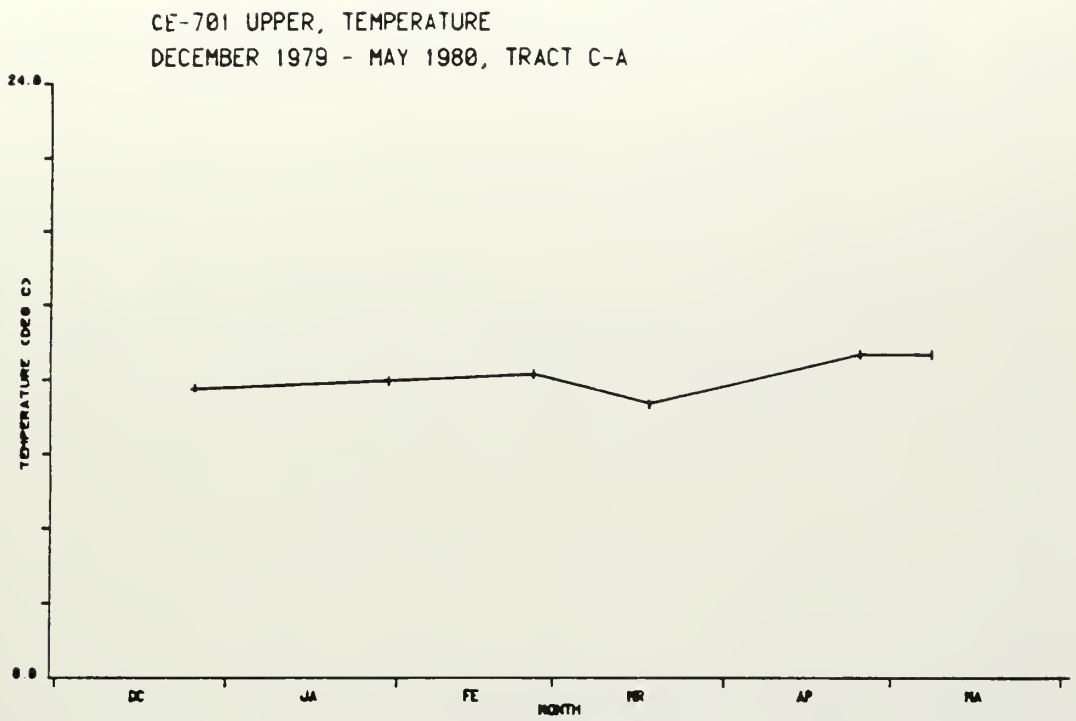

Figure 5-63. Temperature at CE-701 Upper, December 1979 - May 1980, Tract C-a

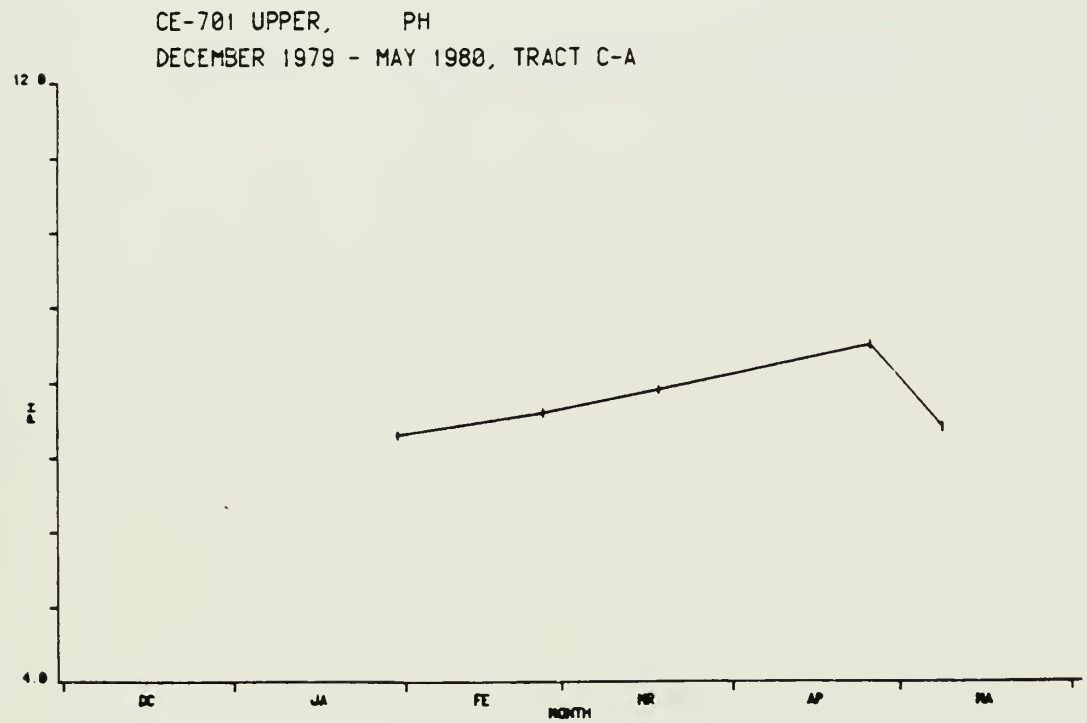

Figure 5-64. pH at CE-701 Upper, December 1979 - May 1980, Tract C-a

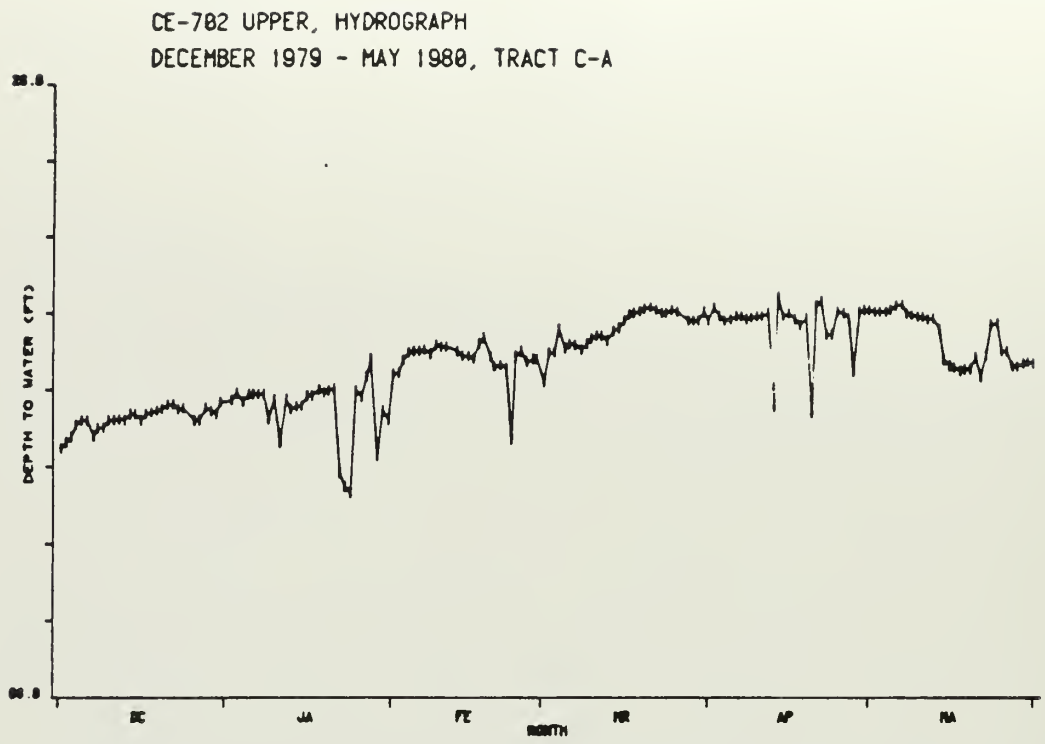

Figure 5-65. Hydrograph of CE-702 Upper, December 1979 - May 1980, Tract C-a

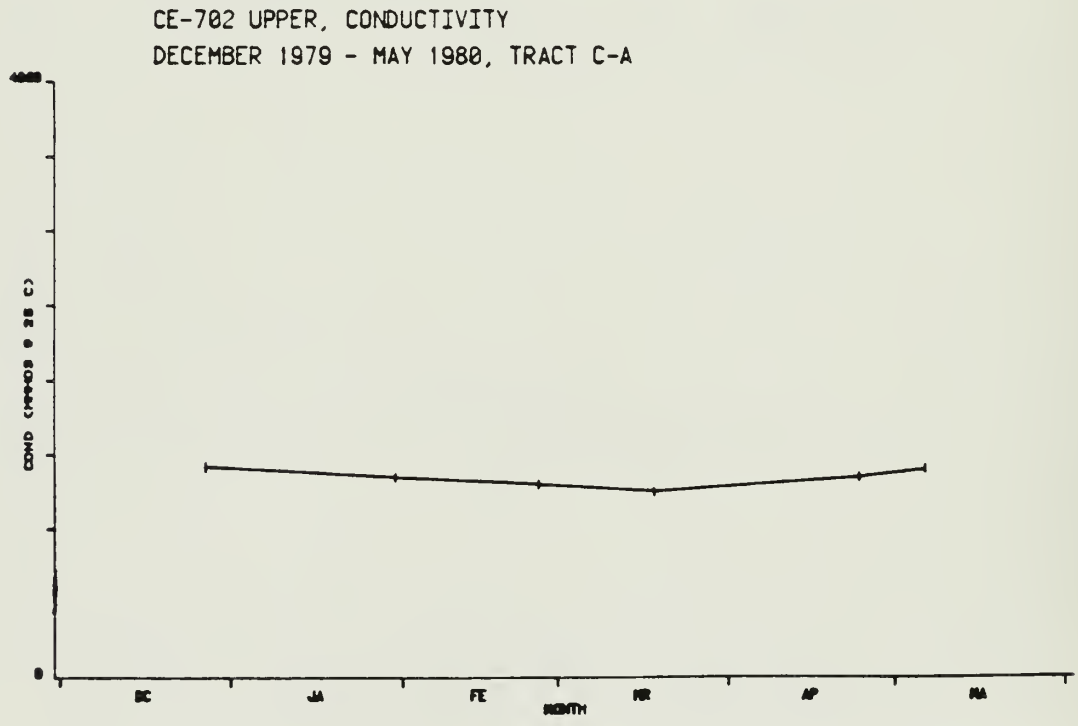

Figure 5-66. Conductivity at CE-702 Upper, December 1979 - May 1980, Tract C-a

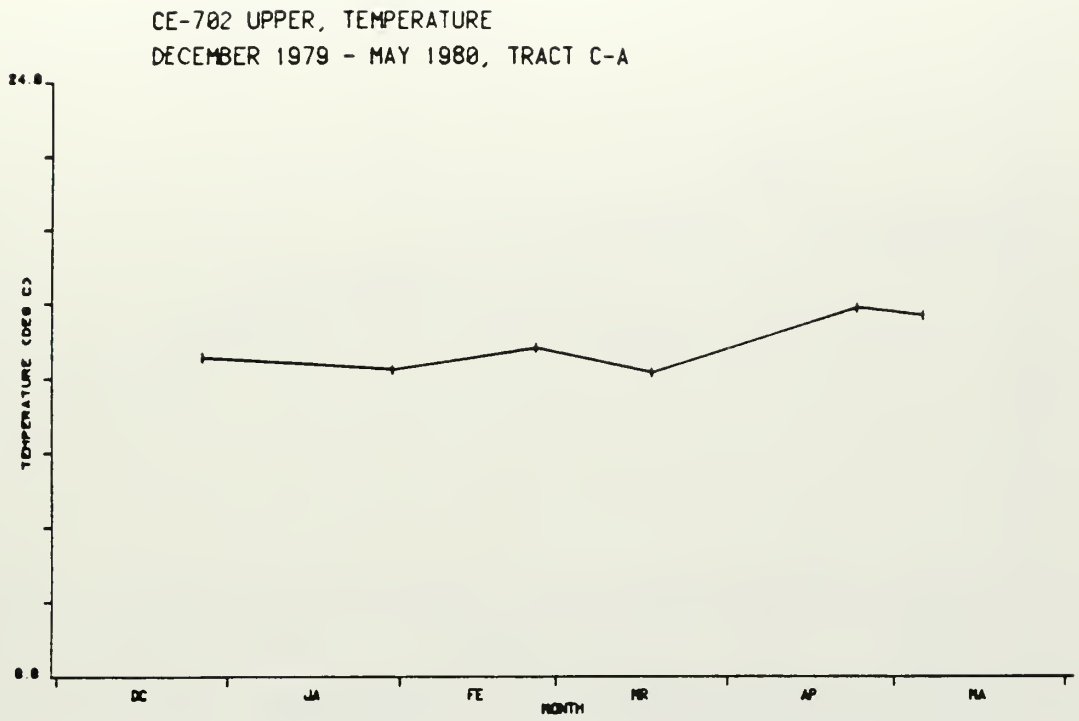

Figure 5-67. Temperature at CE-702 Upper, December 1979 - May 1980, Tract C-a

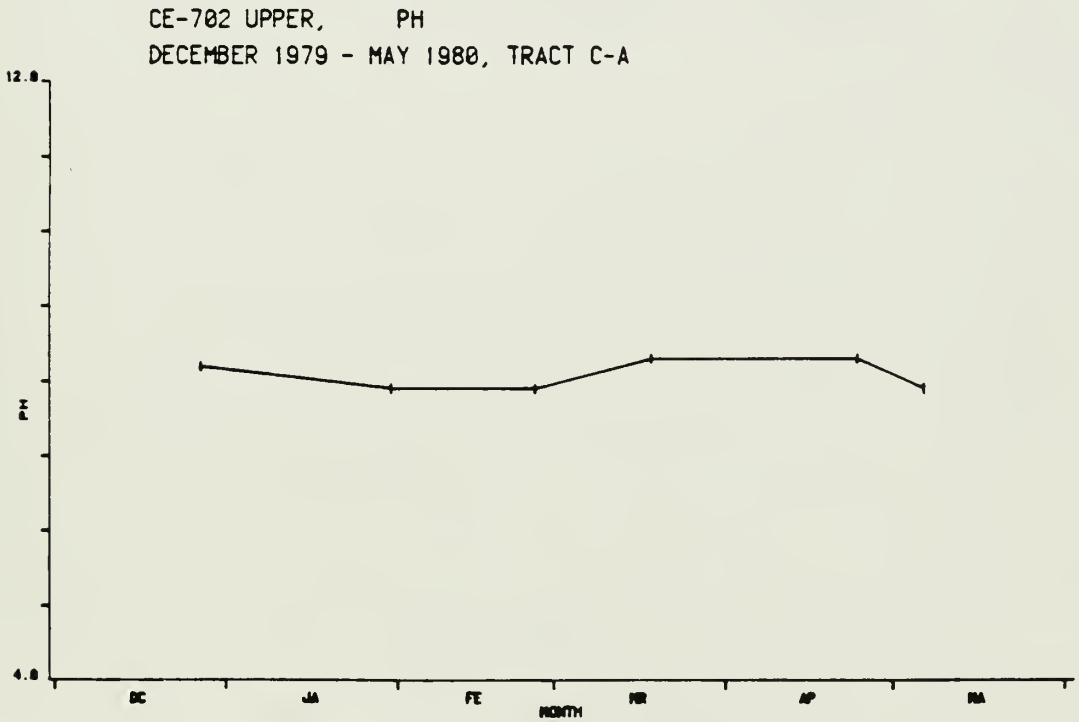

Figure 5-68. pH at CE-702 Upper, December 1979 - May 1980, Tract C-a

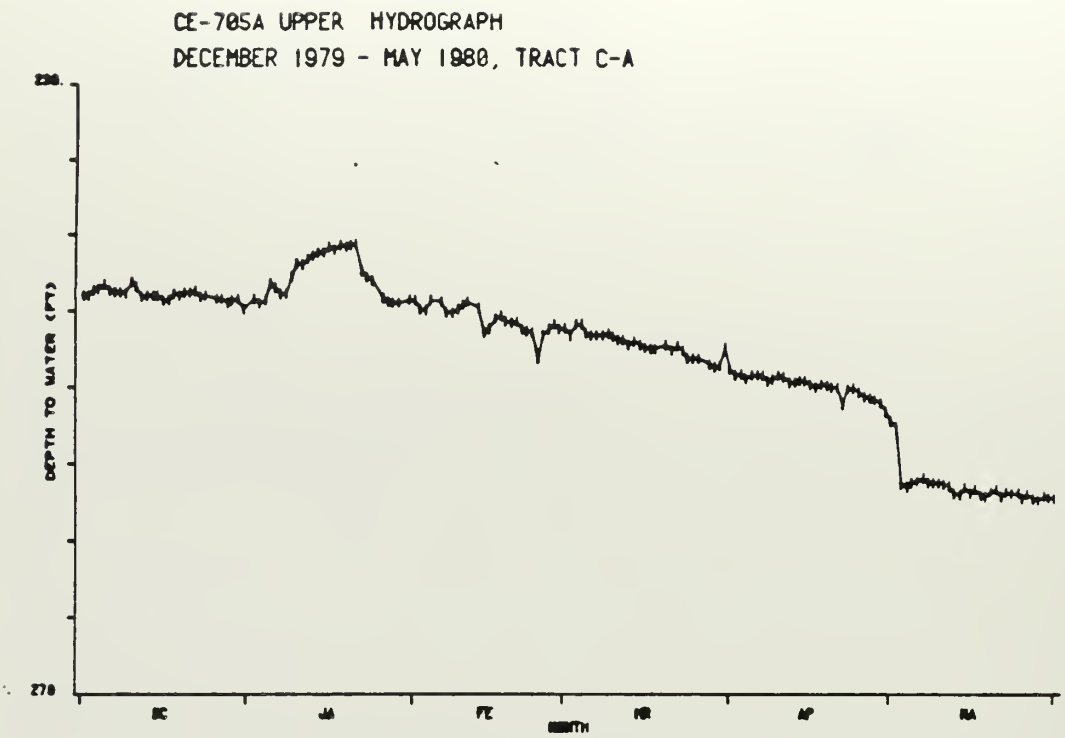

Figure 5-69. Hydrograph of CE-705A Upper, December 1979 - May 1980, Tract C-a

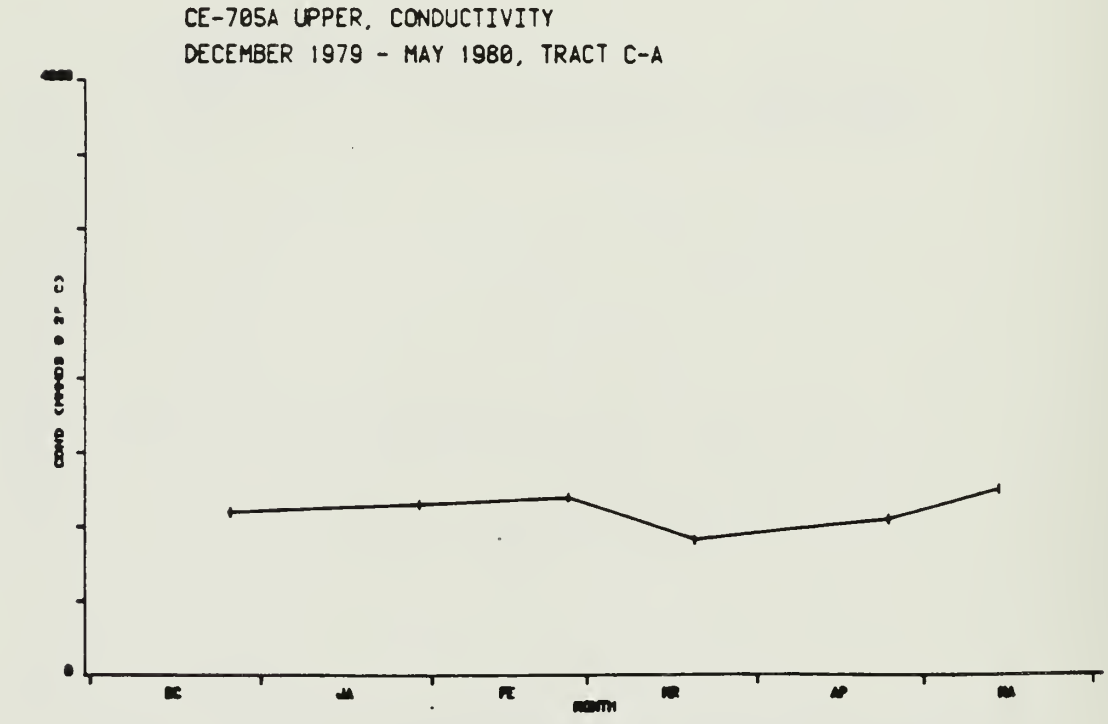

Figure 5-70. Conductivity at CE-705A Upper, December 1979 - May 1980, Tract C-a

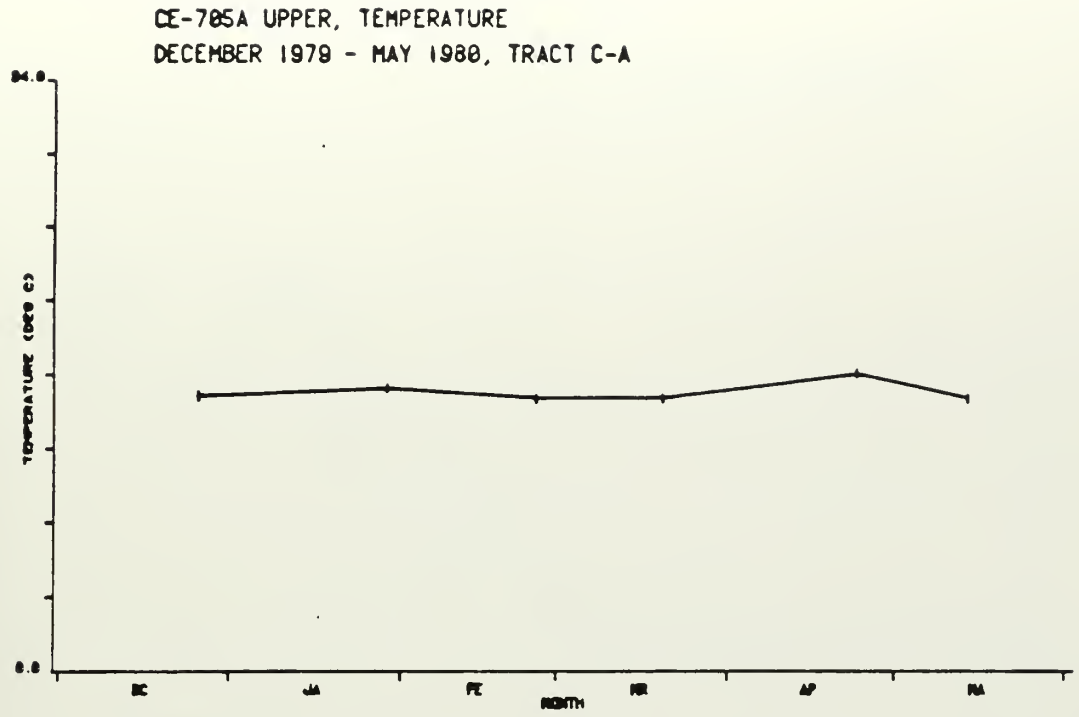

Figure 5-71. Temperature at CE-705A Upper, December 1979 - May 1980, Tract C-a

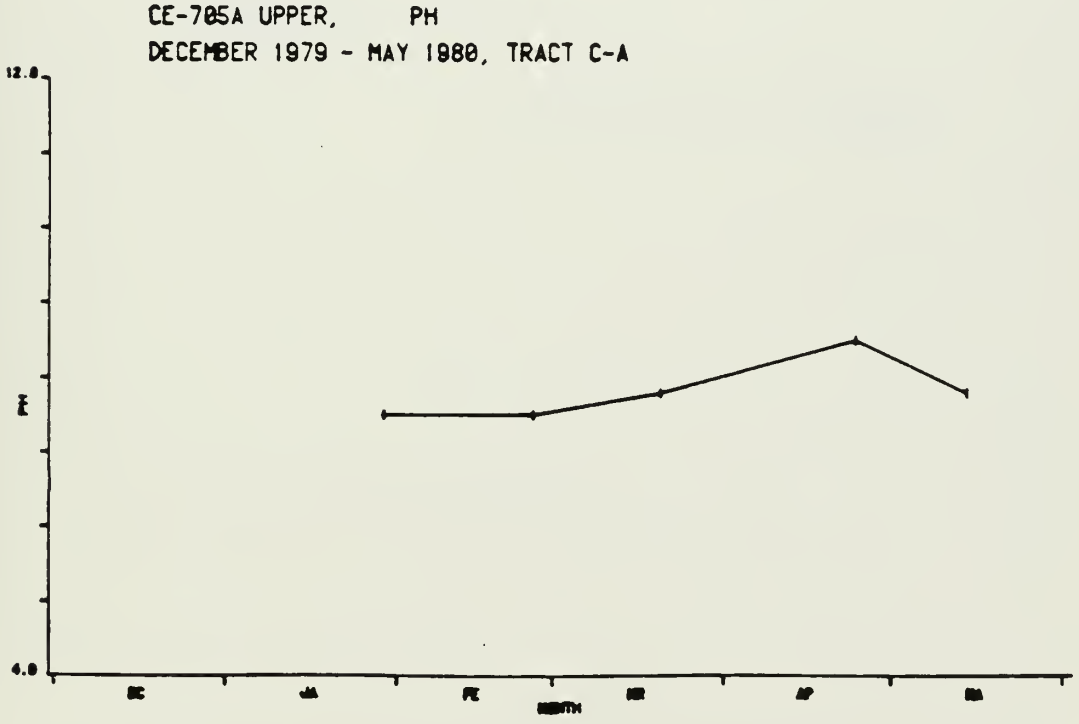

Figure 5-72. pH at CE-705A Upper, December 1979 - May 1980, Tract C-a

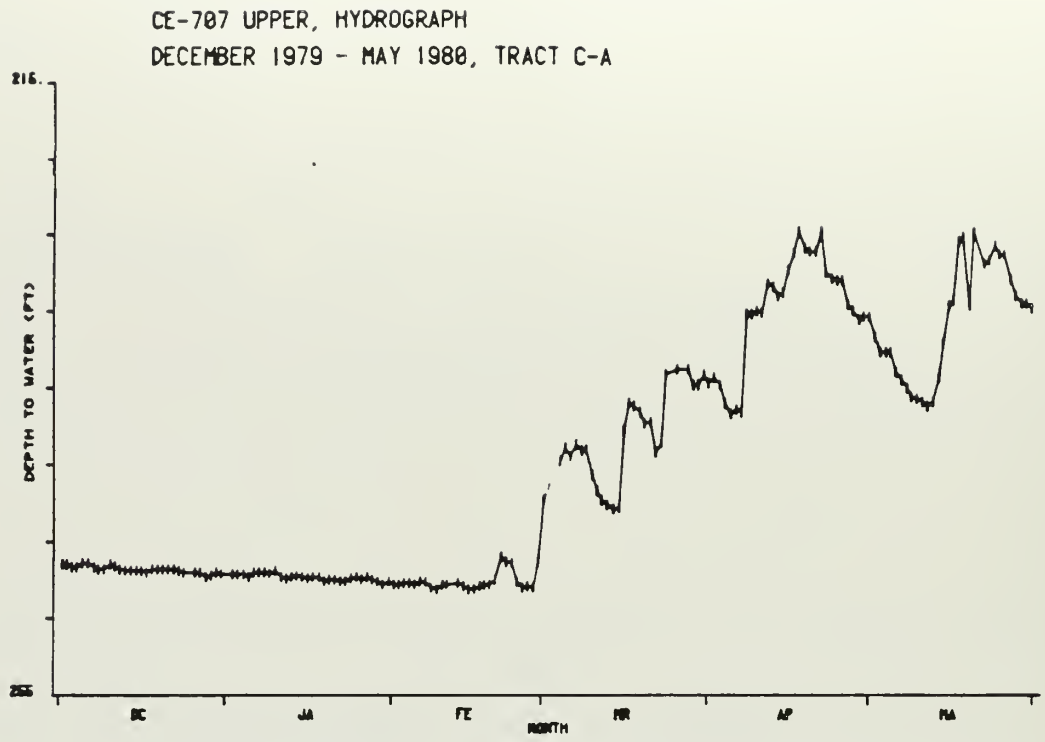

Figure 5-73. Hydrograph of CE-707 Upper, December 1979 - May 1980, Tract C-a

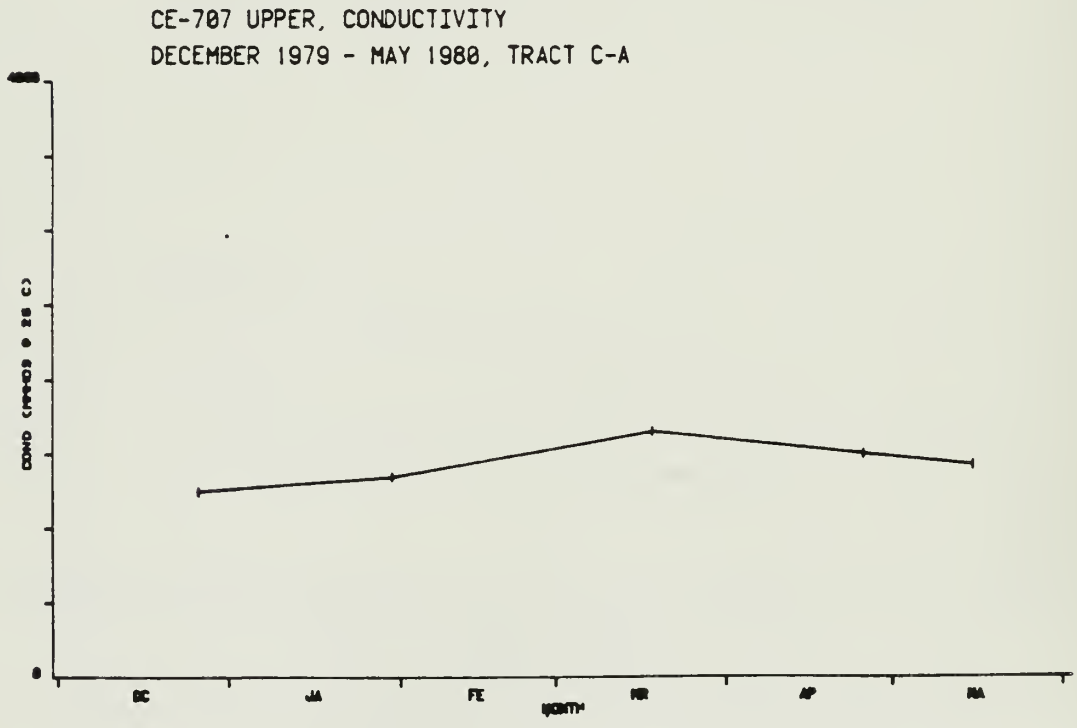

Figure 5-74. Conductivity at CE-707 Upper, December 1979 - May 1980, Tract C-a

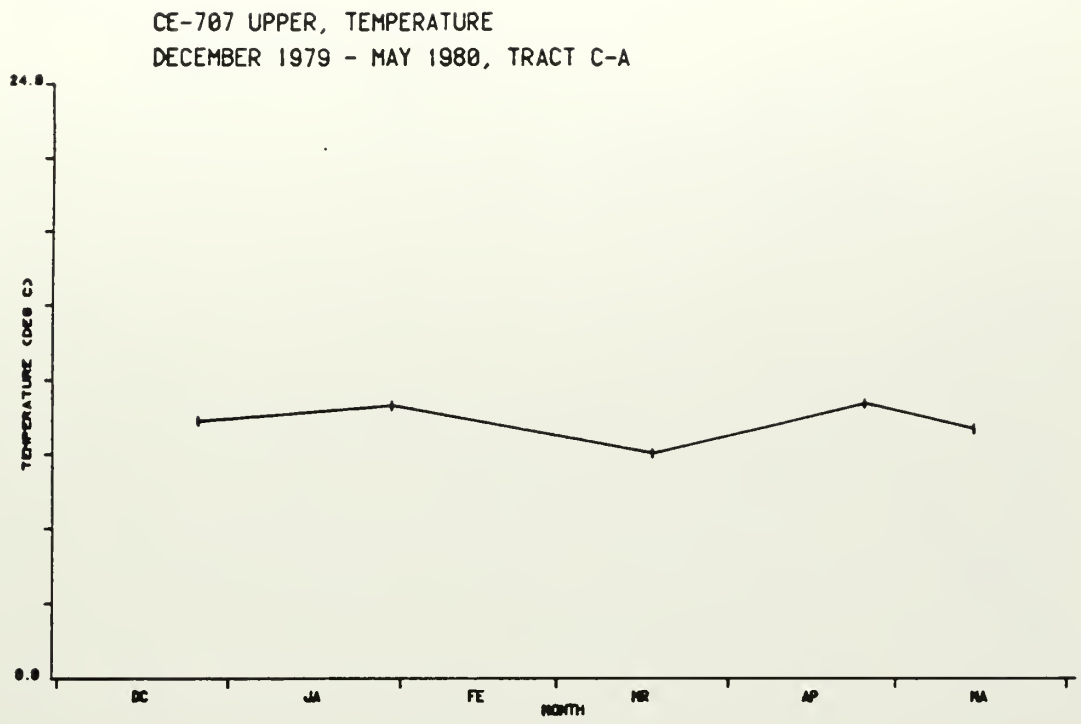

Figure 5-75. Temperature at CE-707 Upper, December 1979 - May 1980, Tract C-a

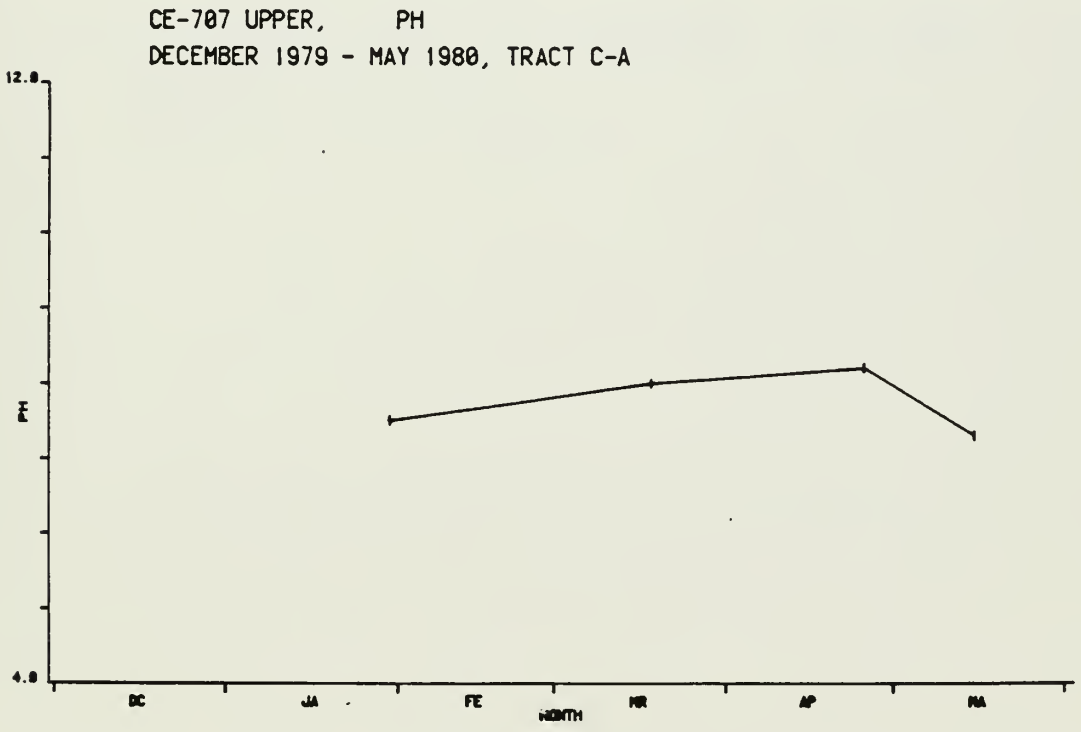

Figure 5-76. pH at CE-707 Upper, December 1979 - May 1980, Tract C-a

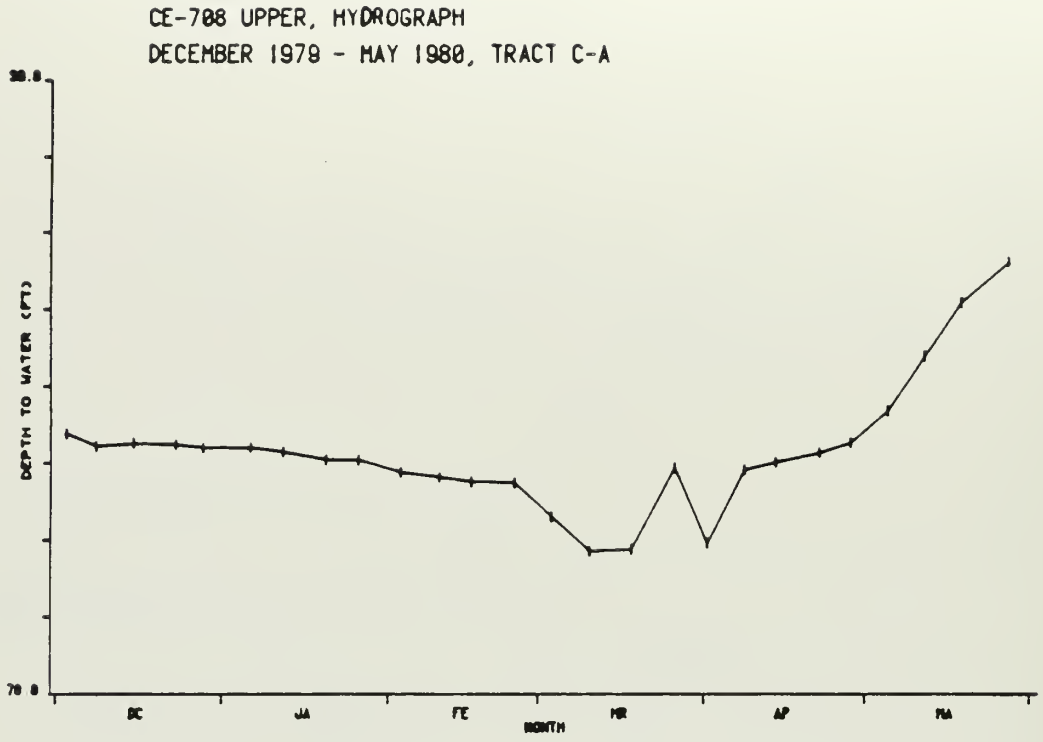

Figure 5-77. Hydrograph of CE-708 Upper, December 1979 - May 1980, Tract C-a

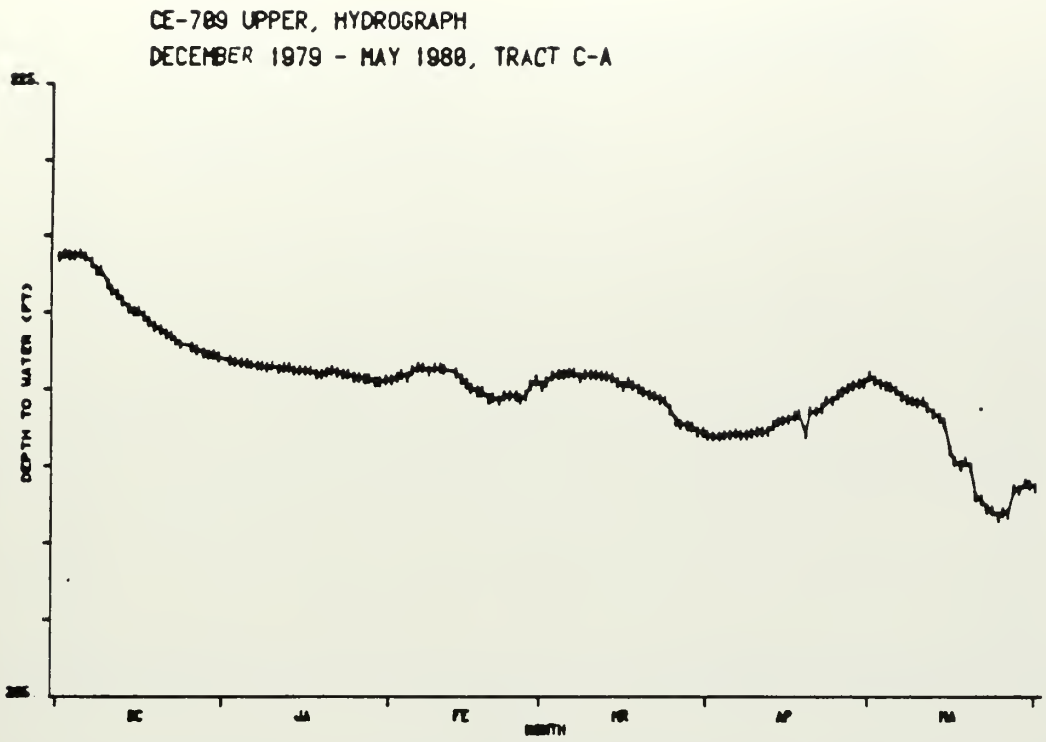

Figure 5-78. Hydrograph of CE-709 Upper, December 1979 - May 1980, Tract C-a

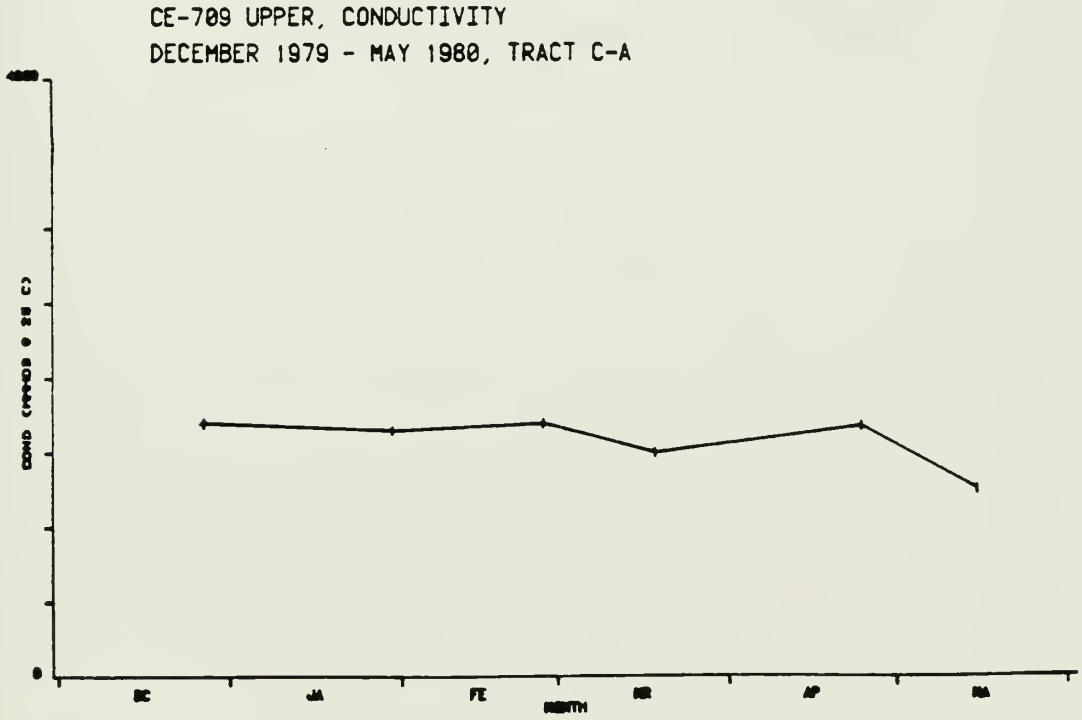

Figure 5-79. Conductivity at CE-709 Upper, December 1979 - May 1980, Tract C-a

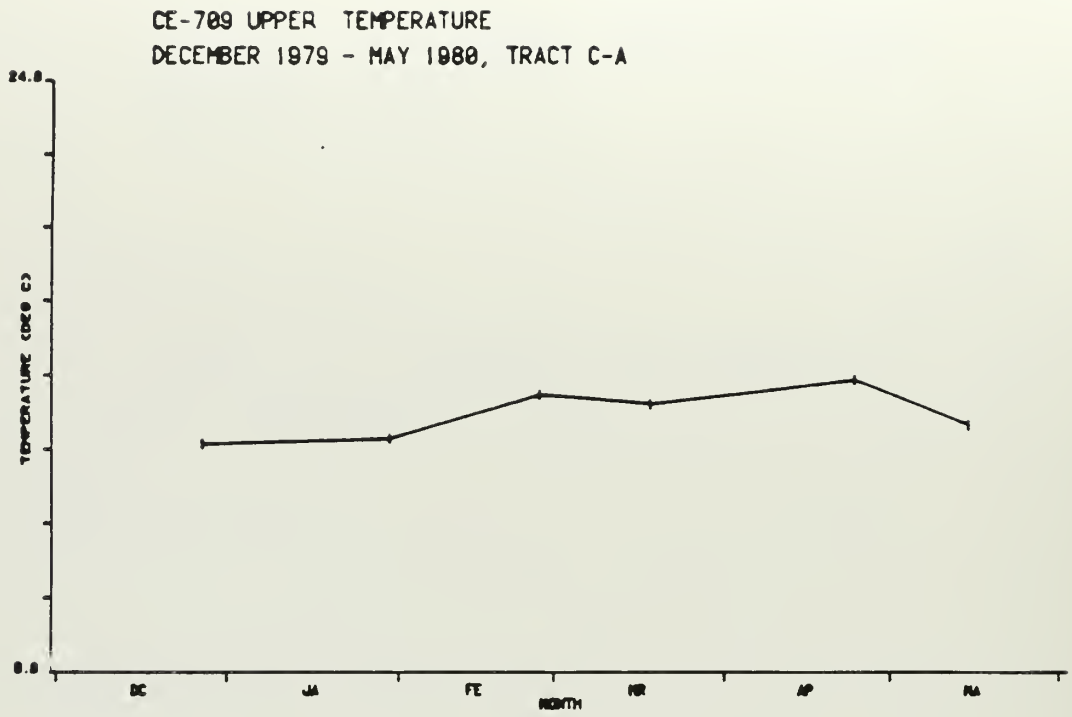

Figure 5-80. Temperature at CE-709 Upper, December 1979 - May 1980, Tract C-a

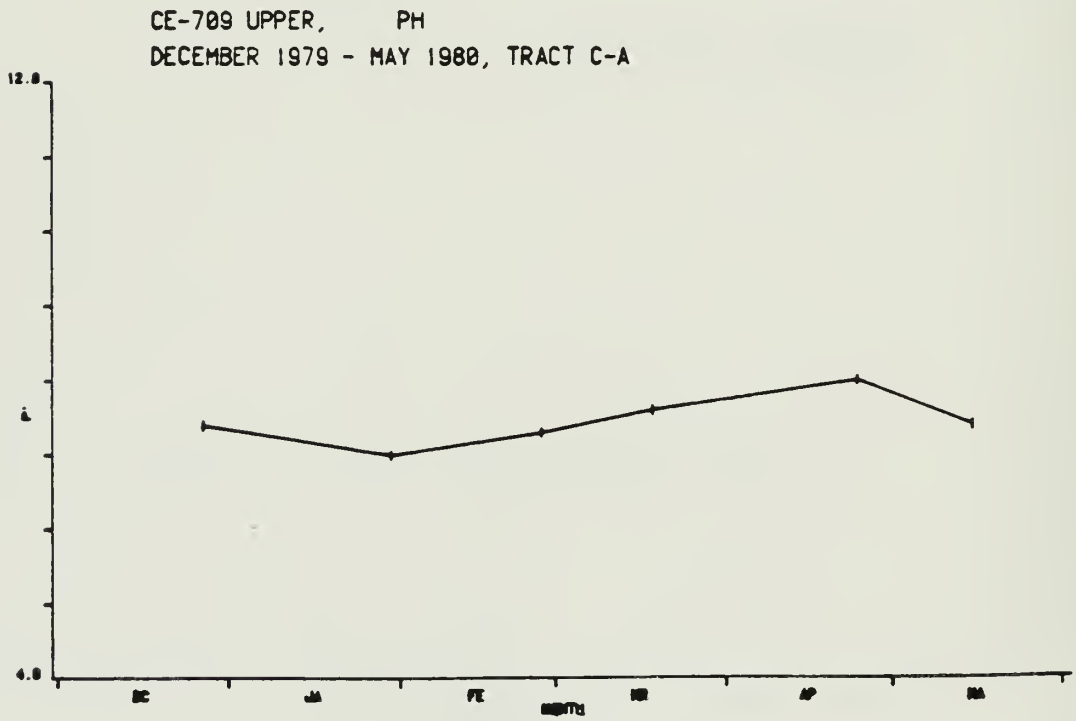

Figure 5-81. pH at CE-709 Upper, December 1979 - May 1980, Tract C-a

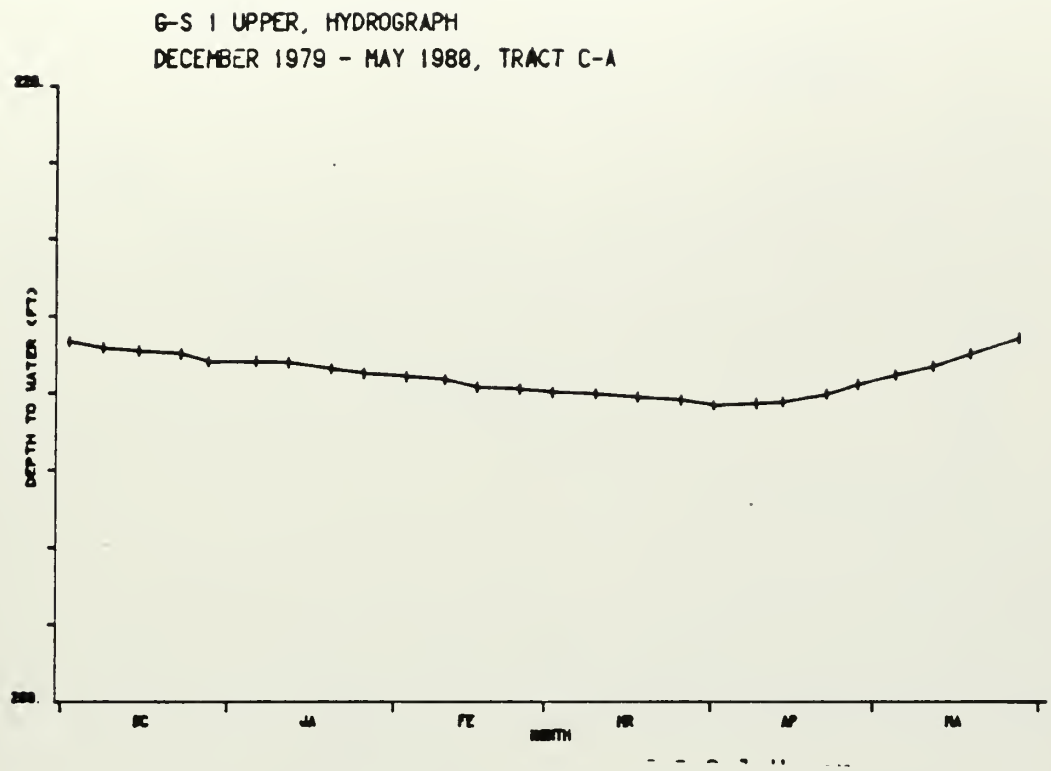

Figure 5-82. Hydrograph of G-S 1 Upper, December 1979 - May 1980, Tract C-a

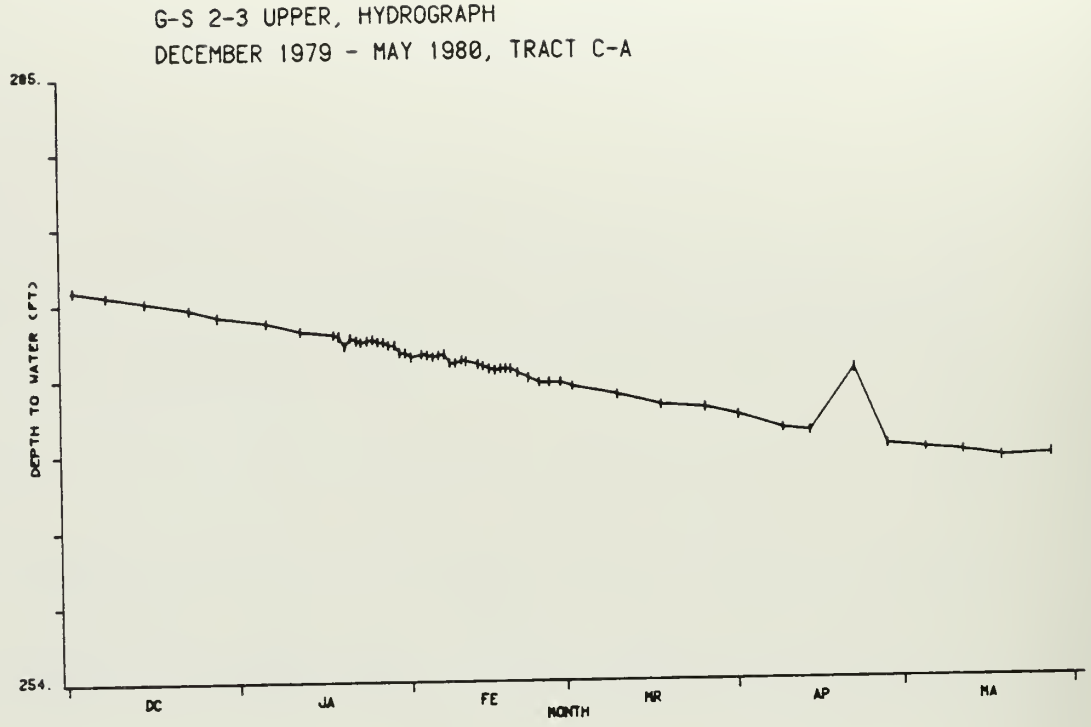

Figure 5-83. Hydrograph of G-S 2-3 Upper, December 1979 - May 1980, Tract C-a

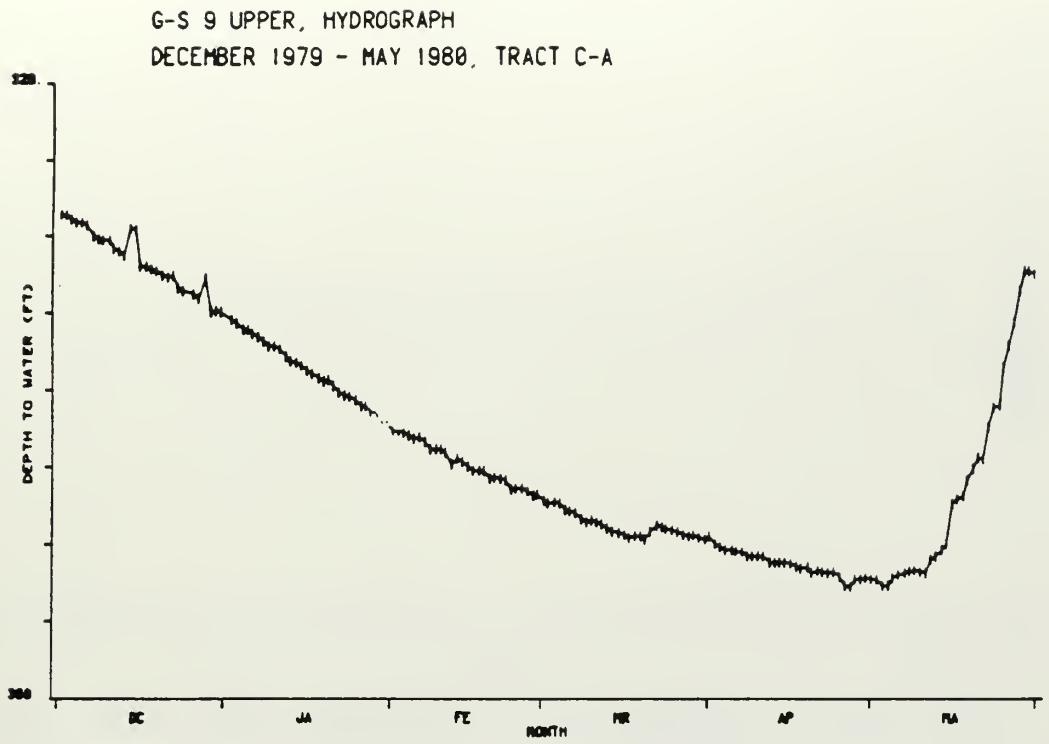

Figure 5-84. Hydrograph of G-S 9 Upper, December 1979 - May 1980, Tract C-a

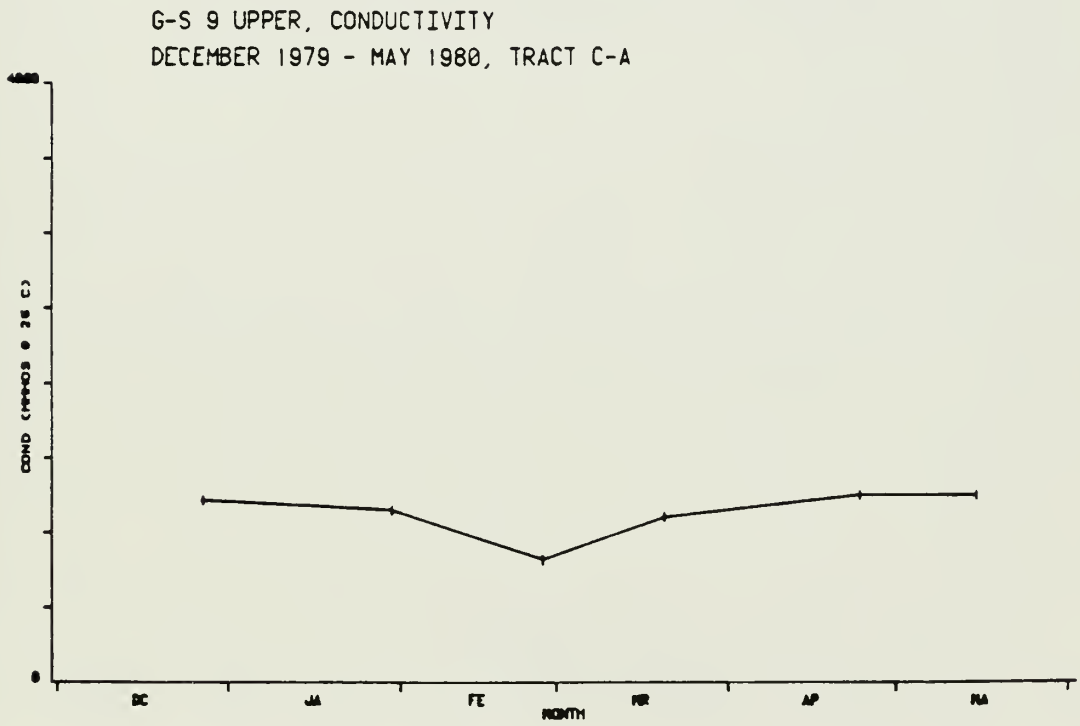

Figure 5-85. Conductivity at G-S 9 Upper, December 1979 - May 1980, Tract C-a

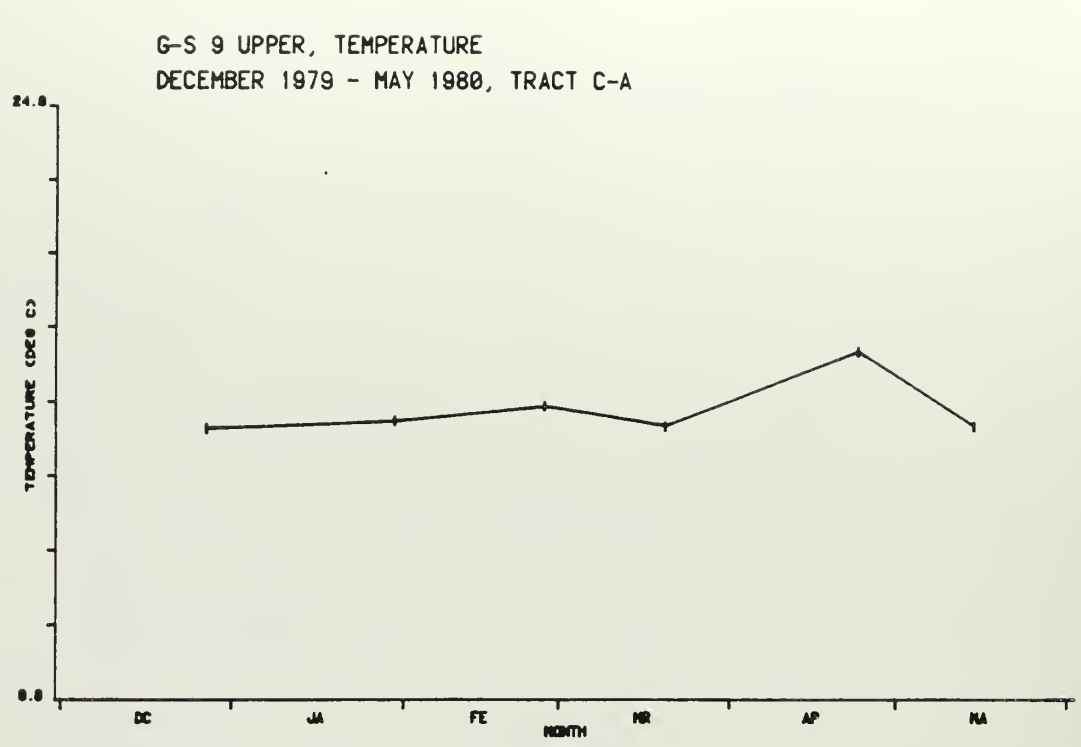

Figure 5-86. Temperature at G-S 9 Upper, December 1979 - May 1980, Tract C-a

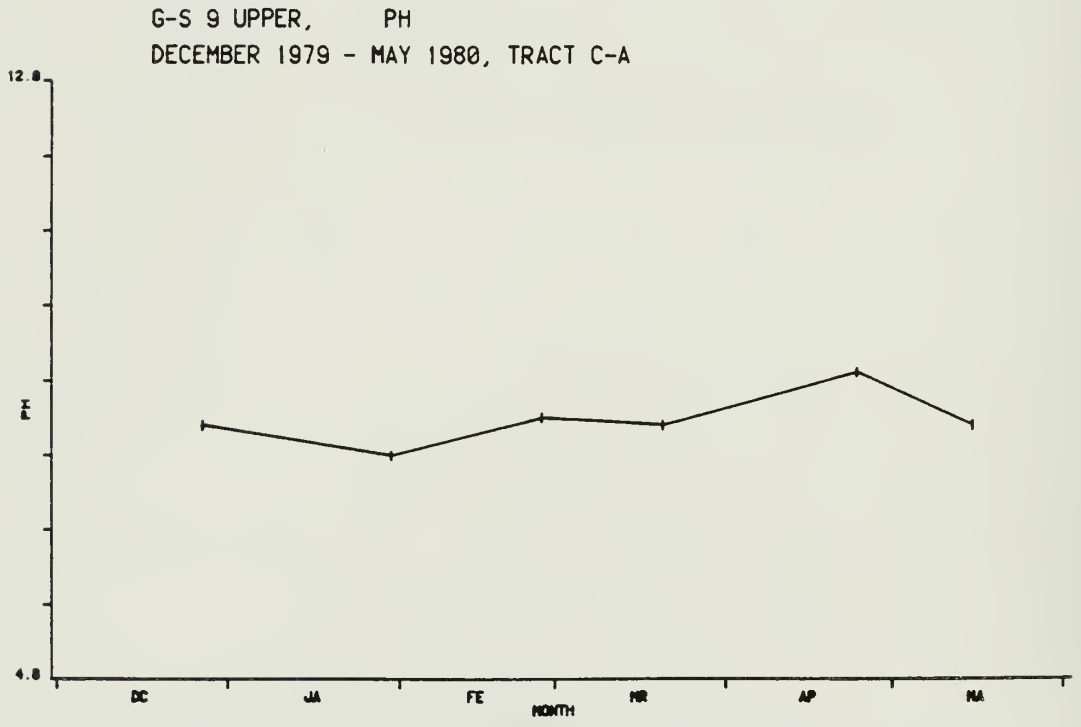

Figure 5-87. pH at G-S 9 Upper, December 1979 - May 1980, Tract C-a

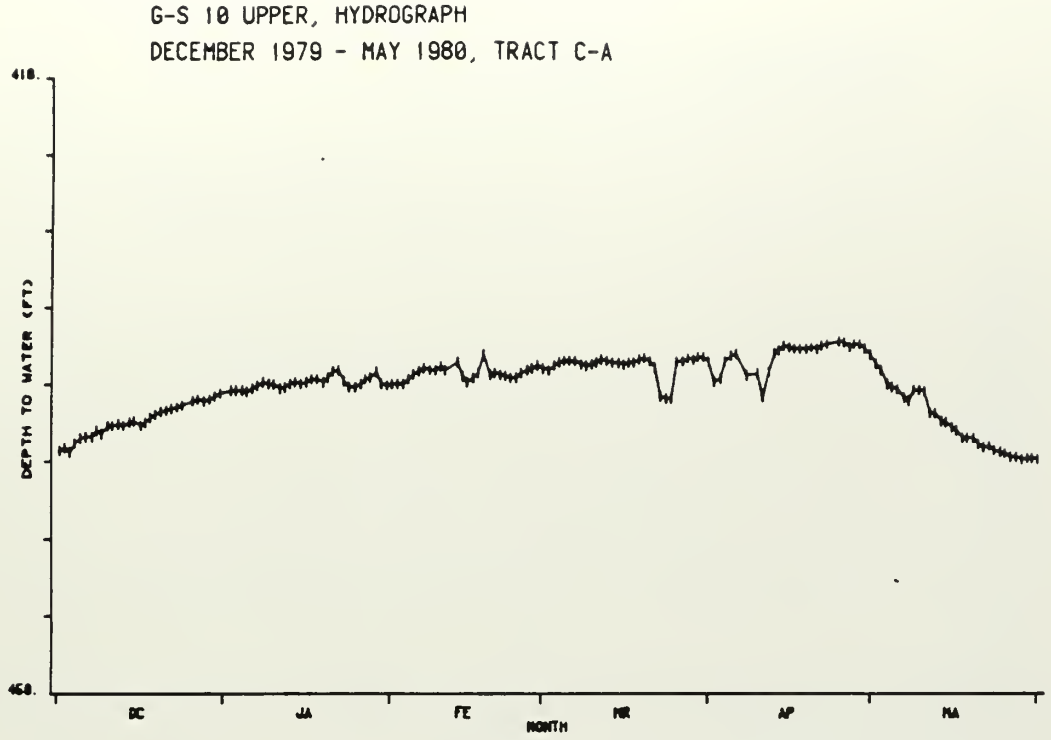

Figure 5-88. Hydrograph of G-S 10 Upper, December 1979 - May 1980, Tract C-a

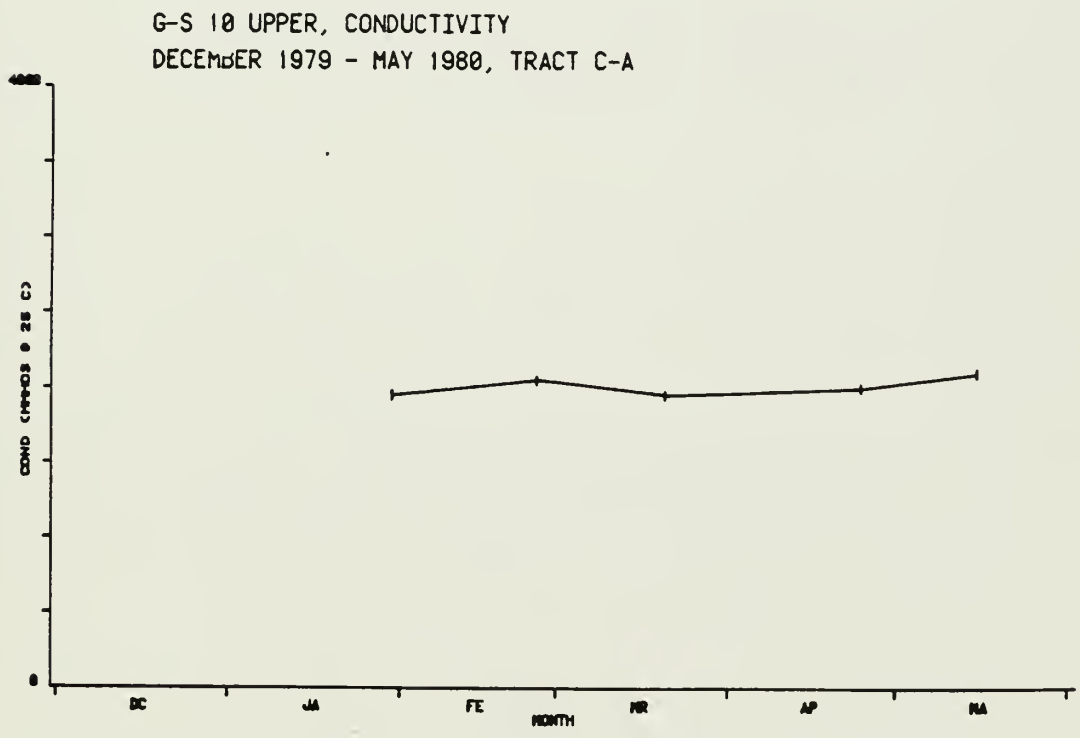

Figure 5-89. Conductivity at G-S 10 Upper, December 1979 - May 1980, Tract C-a

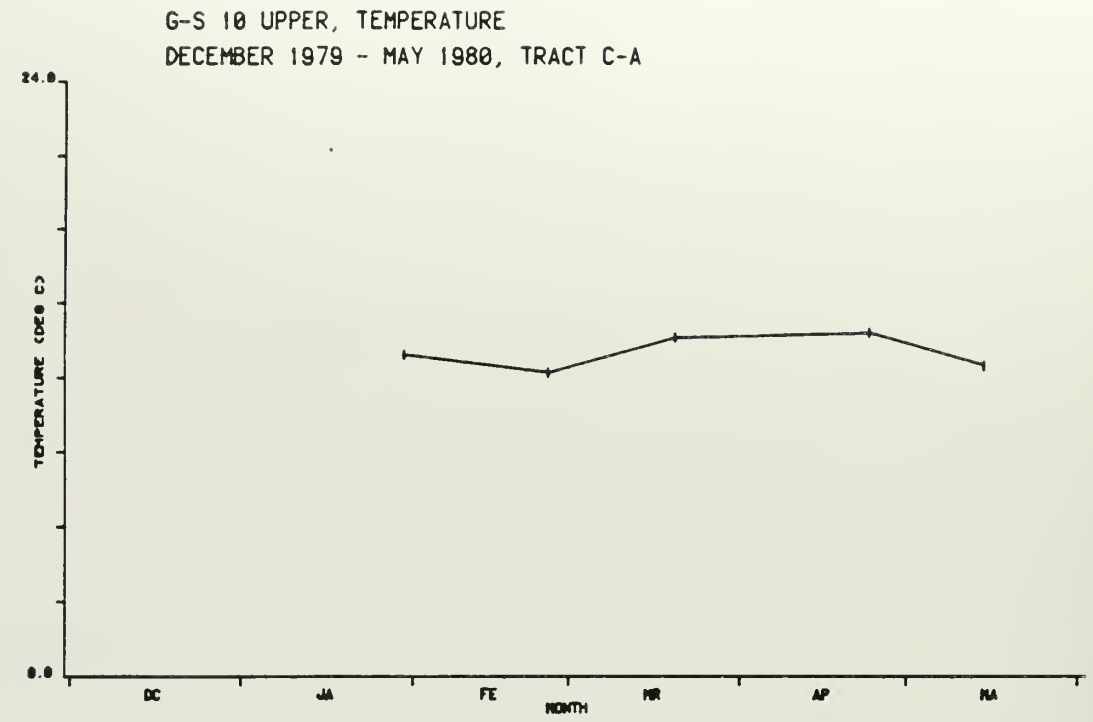

Figure 5-90. Temperature at G-S 10 Upper, December 1979 - May 1980, Tract C-a.

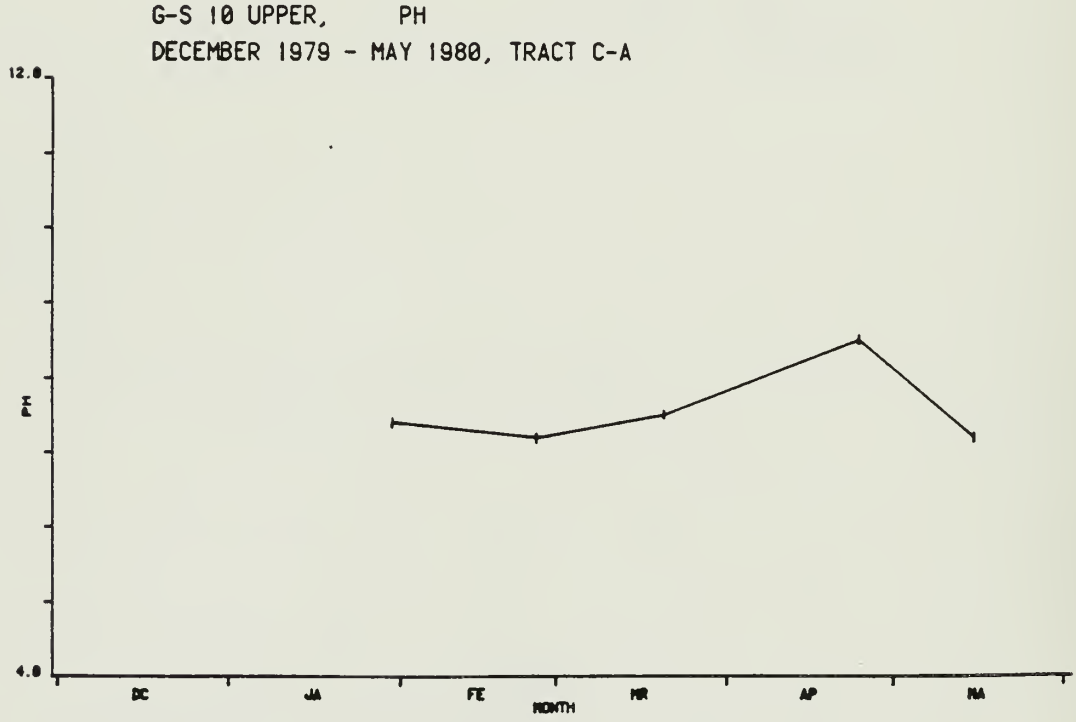

Figure 5-91. pH at G-S 10 Upper, December 1979 - May 1980, Tract C-a

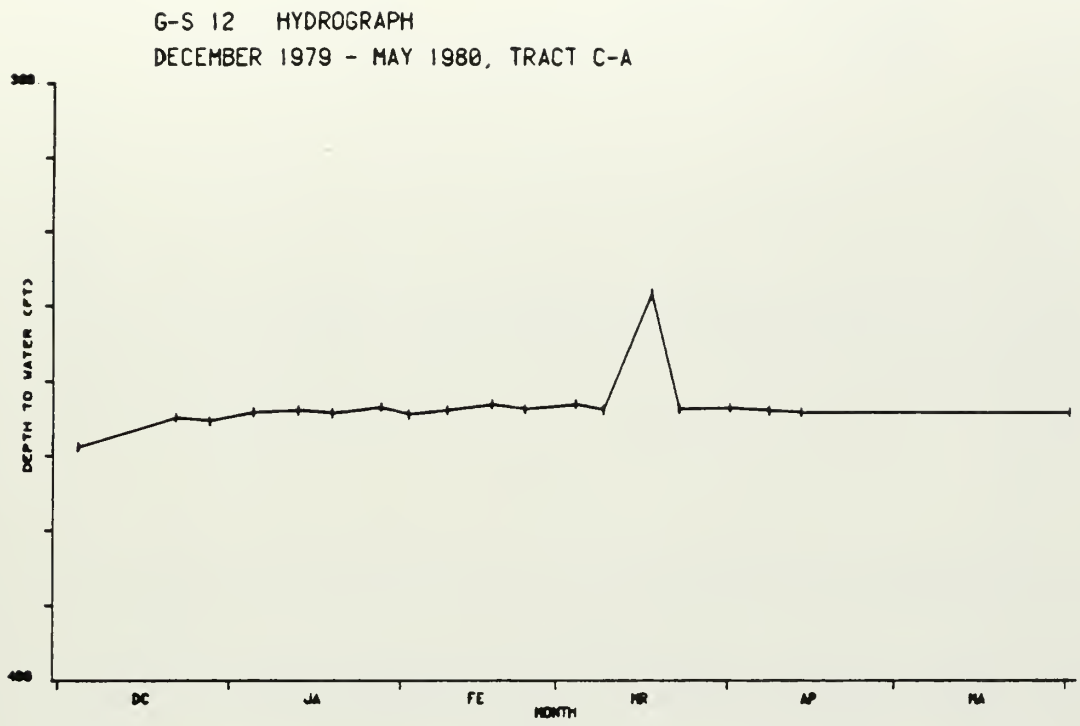

Figure 5-92. Hydrograph of G-S 12, December 1979 - May 1980, Tract C-a

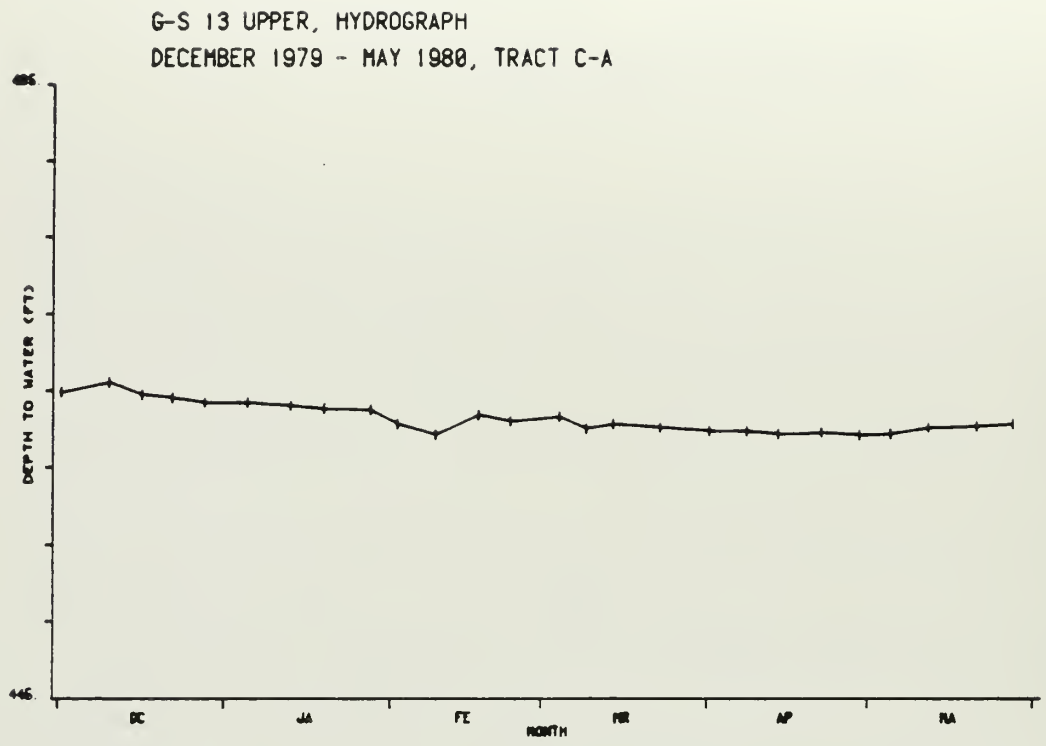

Figure 5-93. Hydrograph of G-S 13 Upper, December 1979 - May 1980, Tract C-a

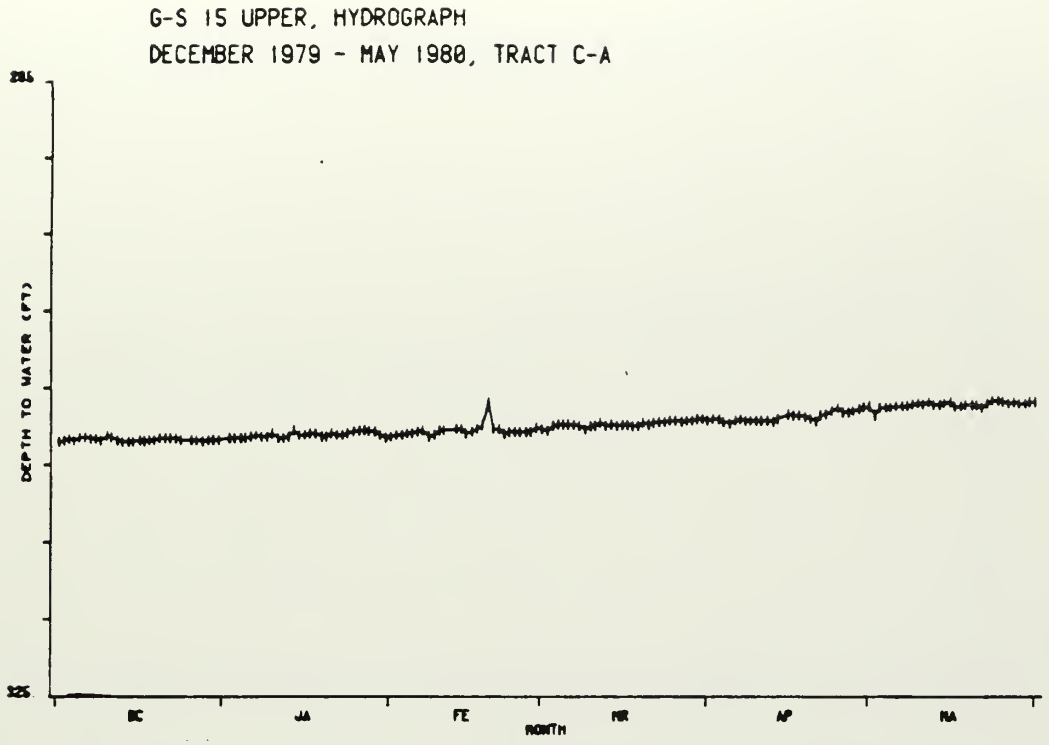

Figure 5-94. Hydrograph of G-S 15 Upper, December 1979 - May 1980, Tract C-a

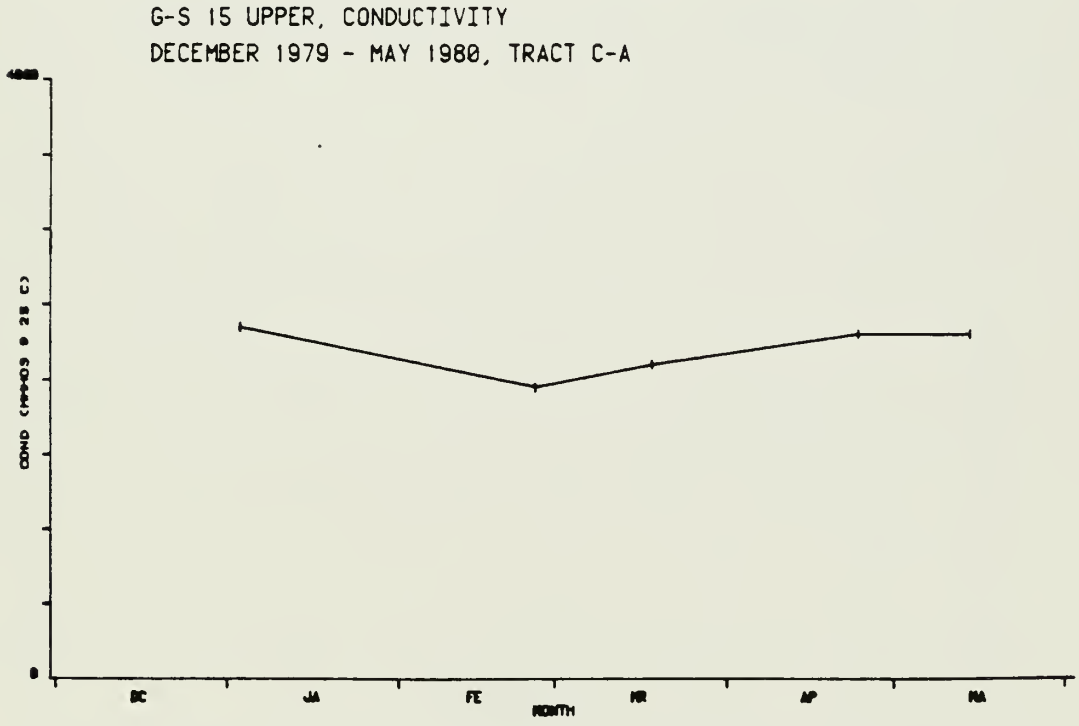

Figure 5-95. Conductivity at G-S 15 Upper, December 1979 - May 1980, Tract C-a

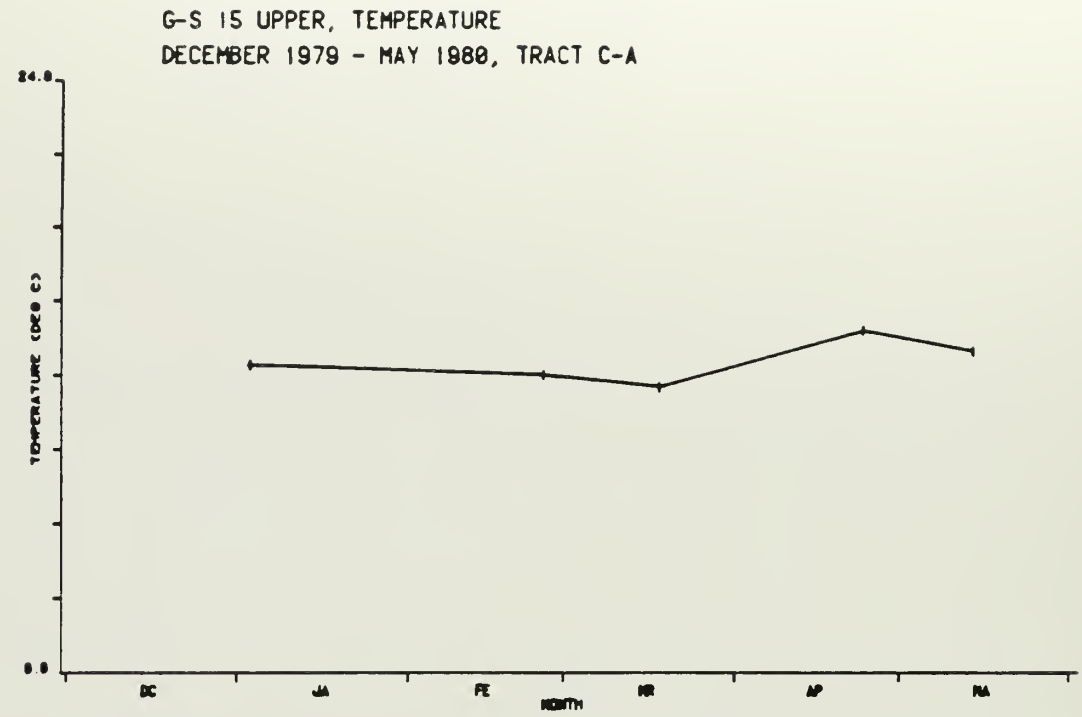

Figure 5-96. Temperature at G-S 15 Upper, December 1979 - May 1980, Tract C-a

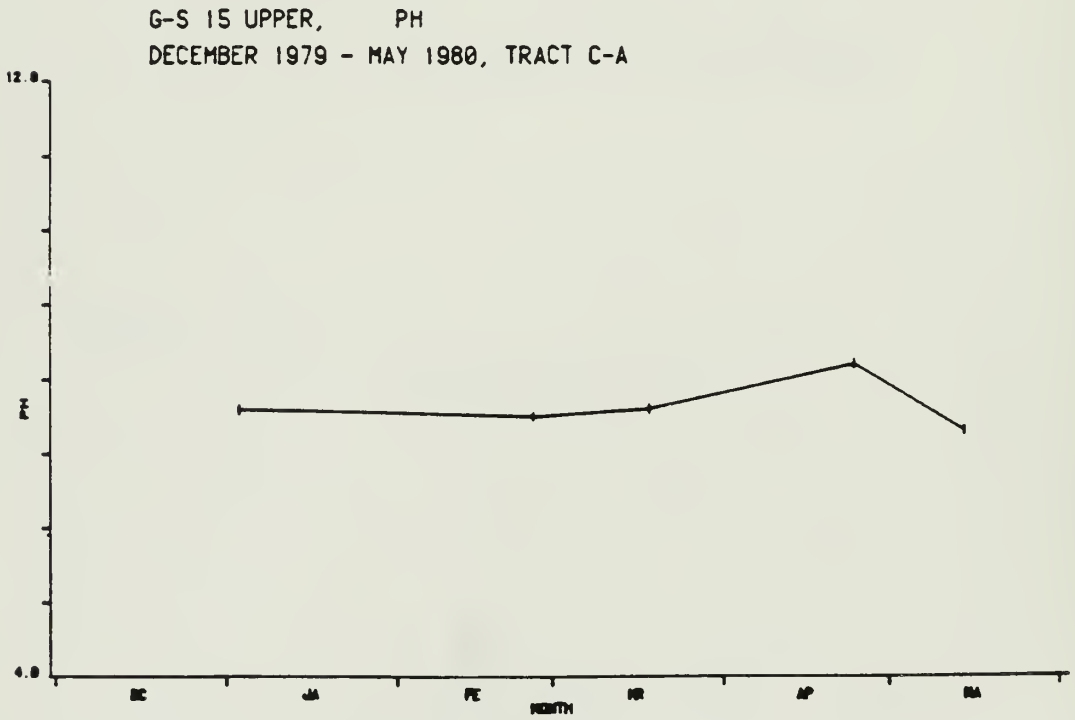

Figure 5-97. pH at G-S 15 Upper, December 1979 - May 1980, Tract C-a

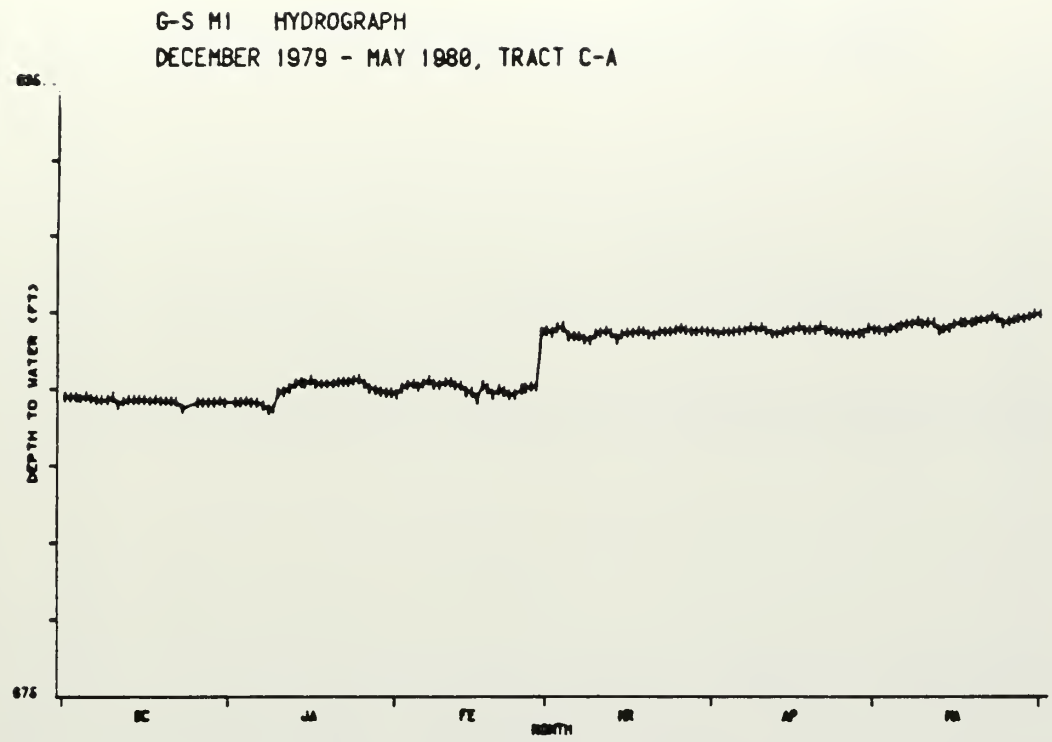

Figure 5-98. Hydrograph of G-S M1, December 1979 - May 1980, Tract C-a

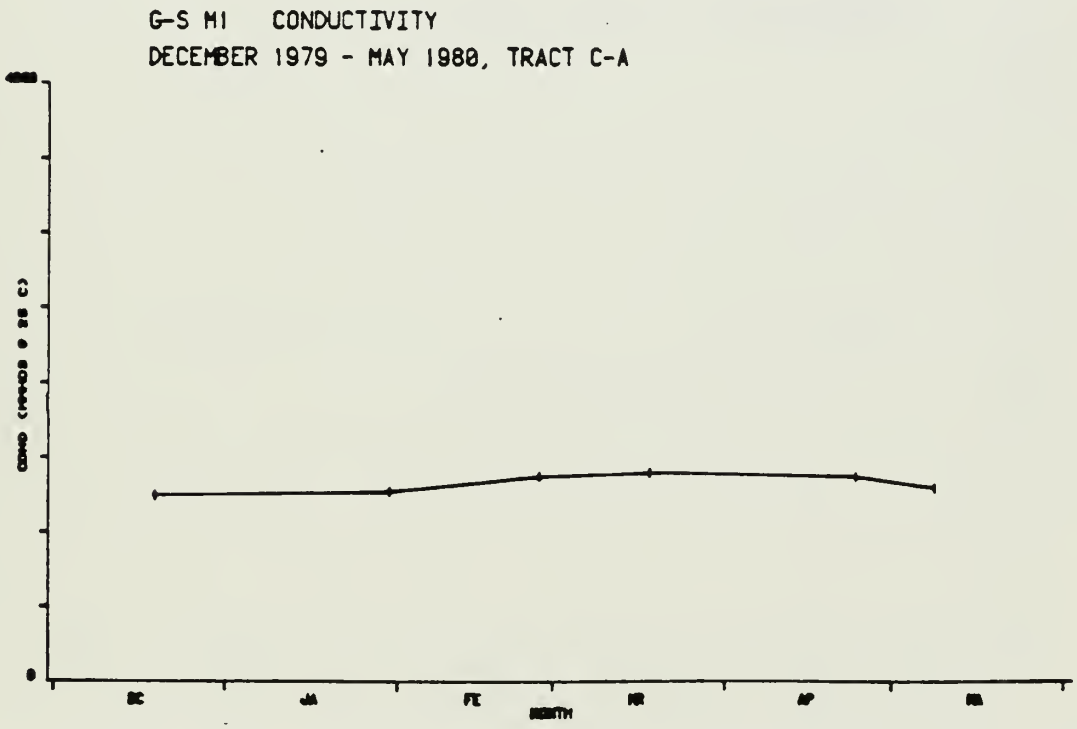

Figure 5-99. Conductivity at G-S M1, December 1979 - May 1980, Tract C-a

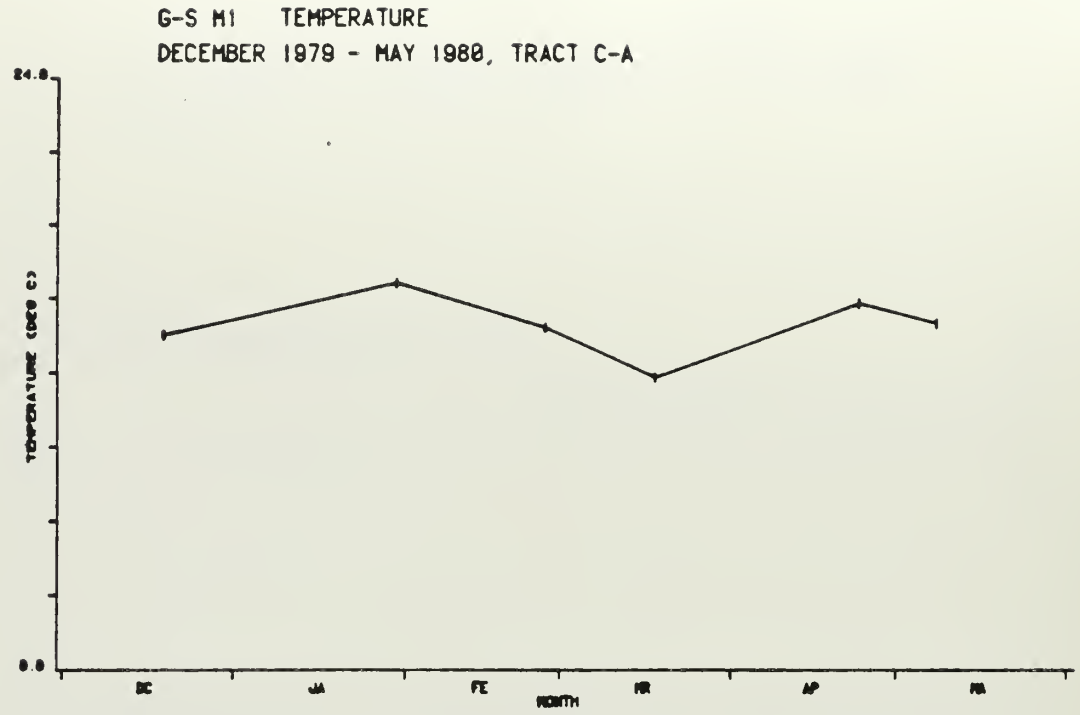

Figure 5-100. Temperature at G-S M1, December 1979 - May 1980, Tract C-a

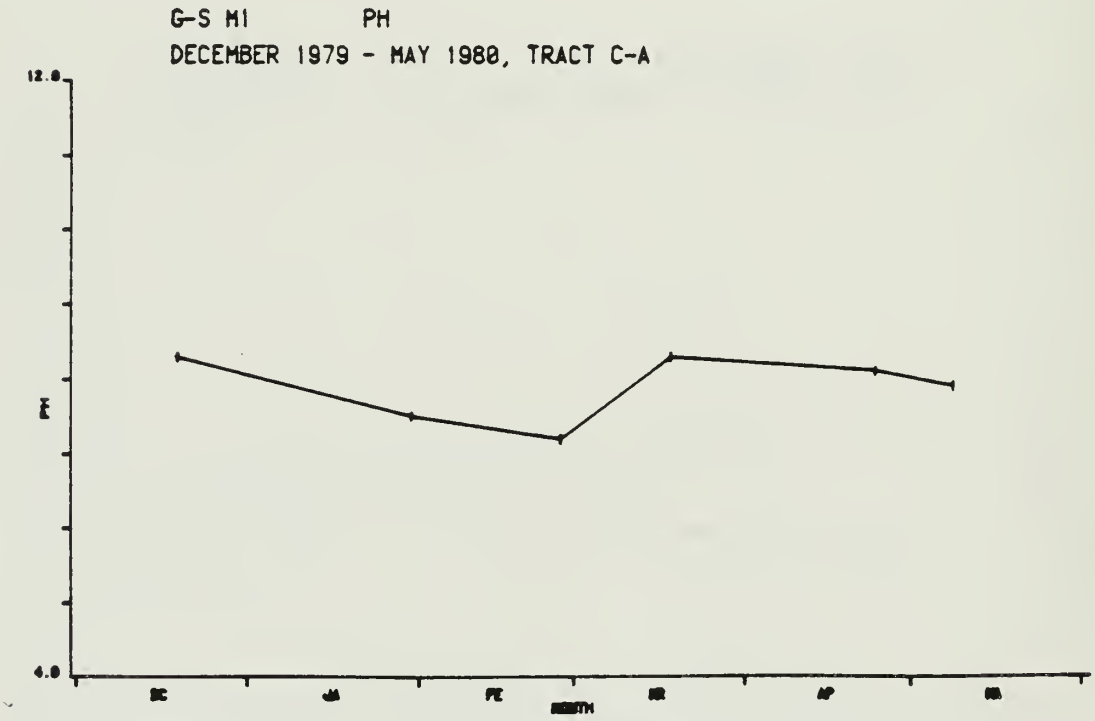

Figure 5-101. pH at G-S M1, December 1979 - May 1980, Tract C-a

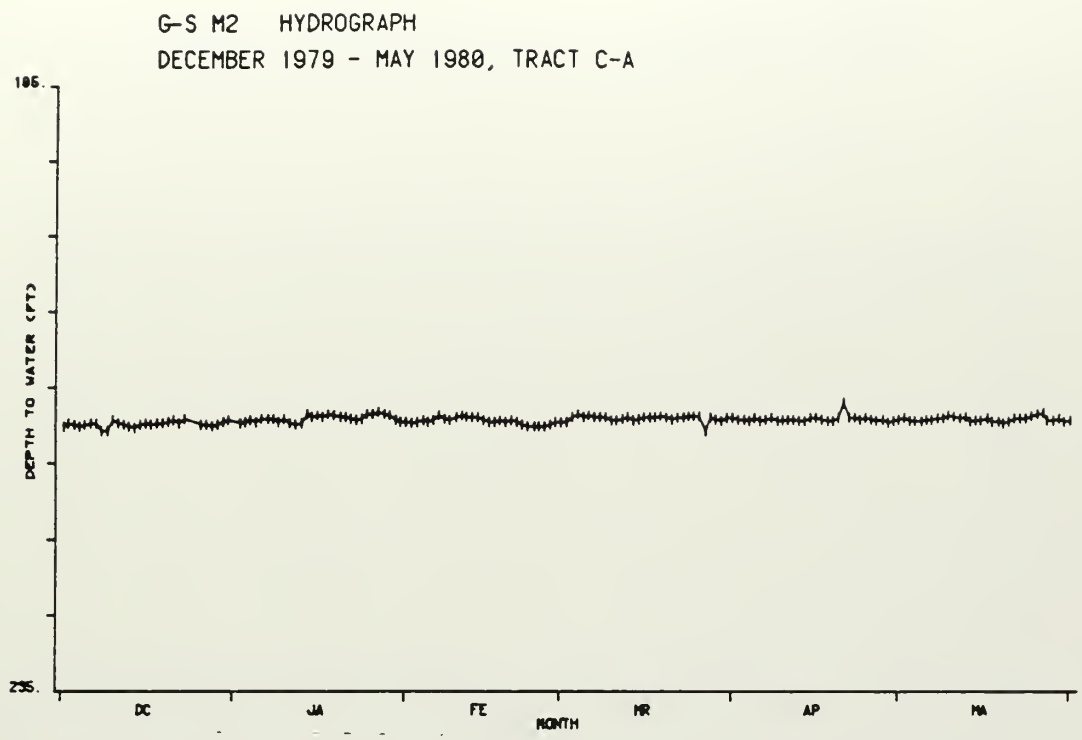

Figure 5-102. Hydrograph of G-S M2, December 1979 - May 1980, Tract C-a

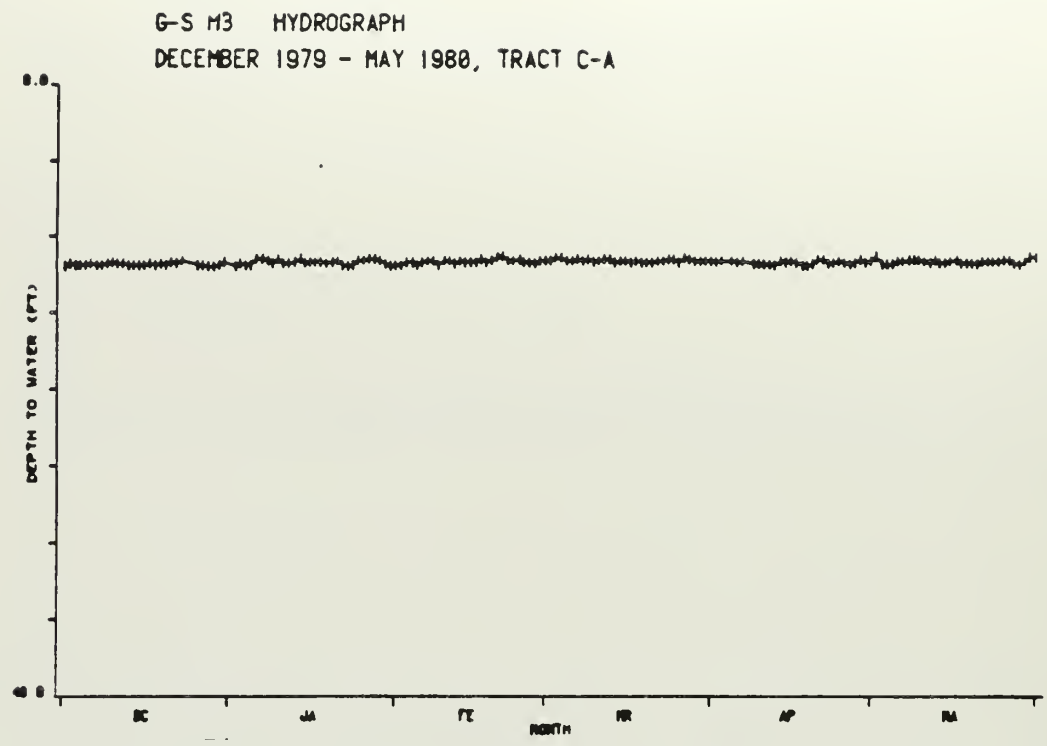

Figure 5-103. Hydrograph of G-S M3, December 1979 - May 1980, Tract C-a

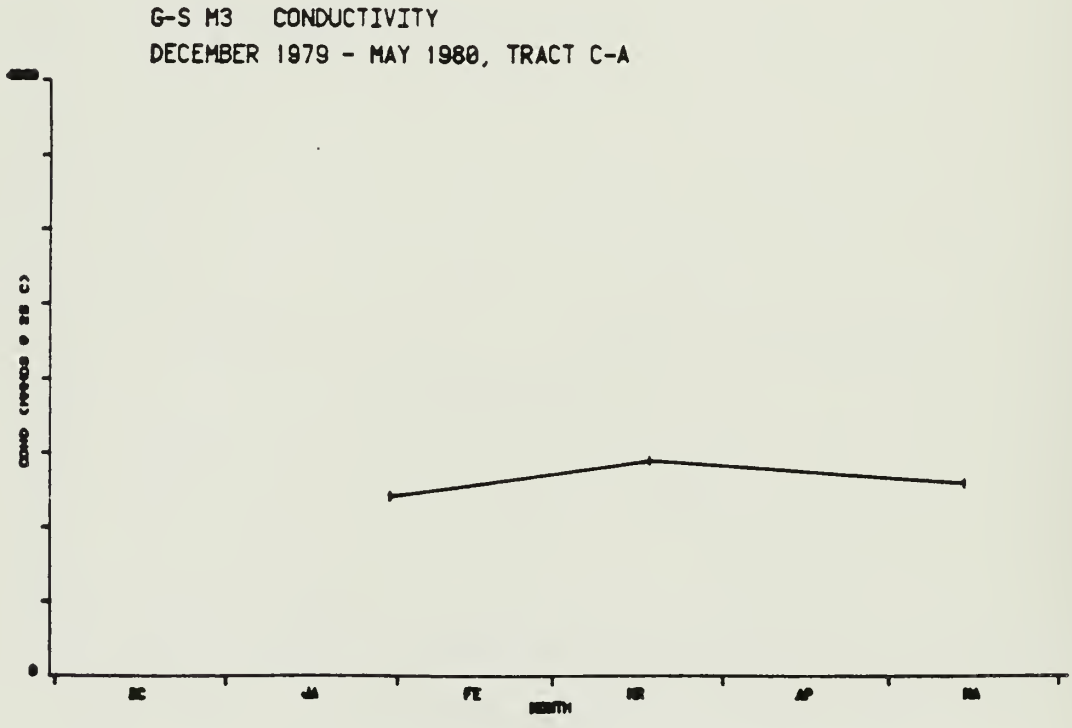

Figure 5-104. Conductivity at G-s M3, December 1979 - May 1980, Tract C-a

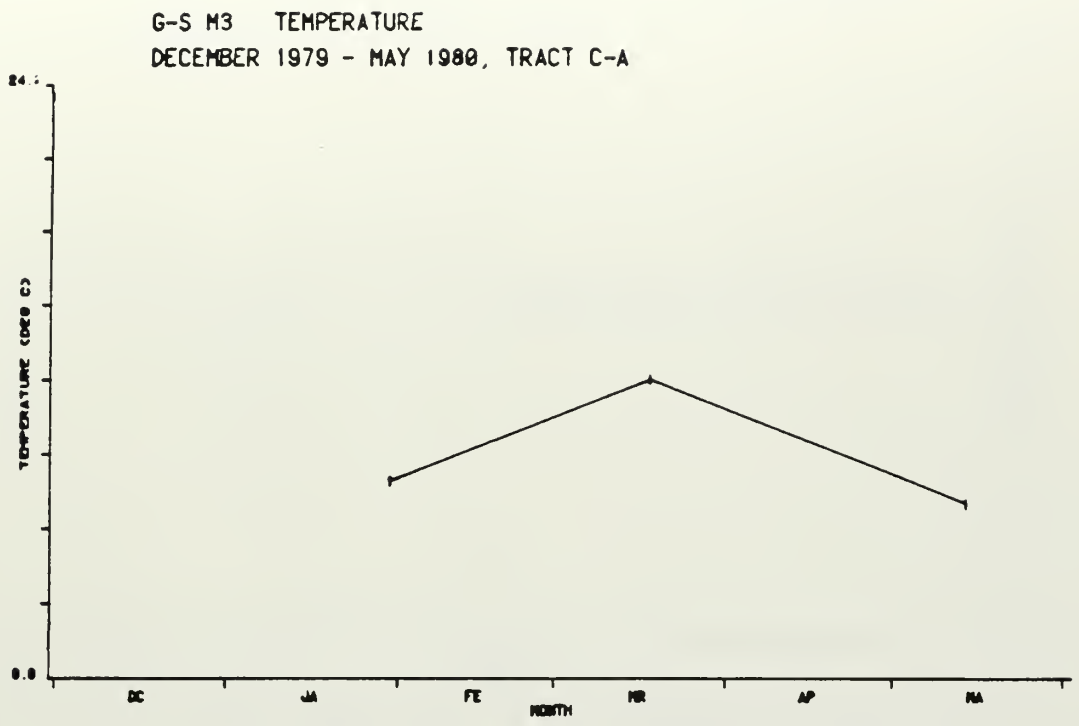

Figure 5-105. Temperature at G-S M3, December 1979 - May 1980, Tract C-a

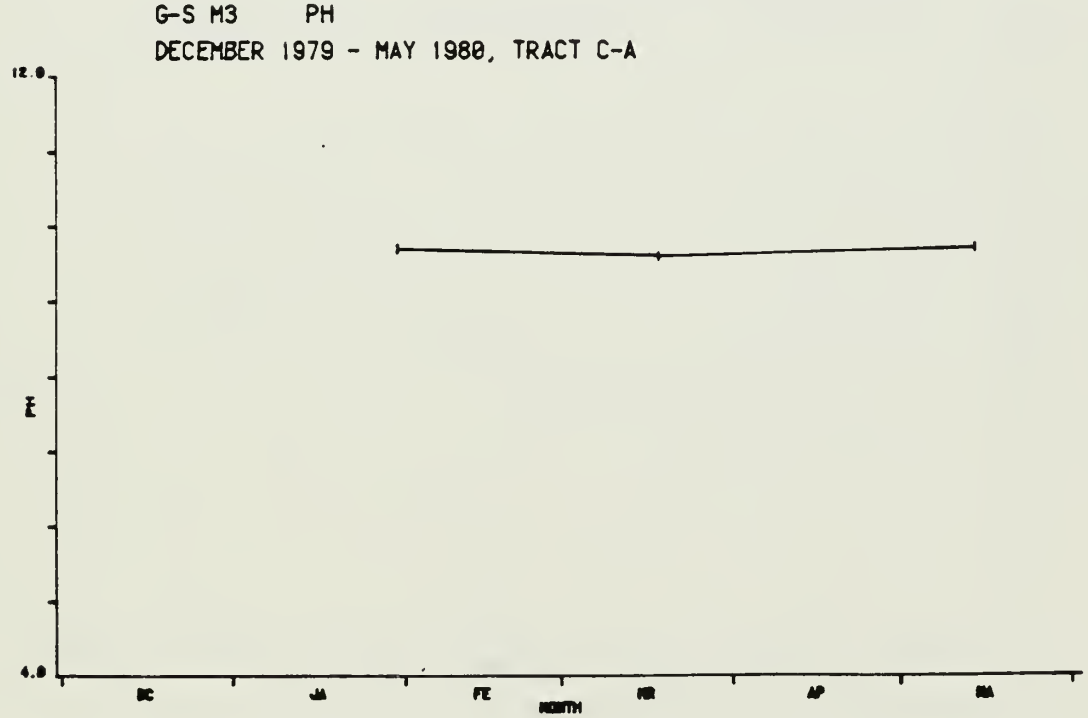

Figure 5-106. pH at G-S M3, December 1979 - May 1980, Tract C-a

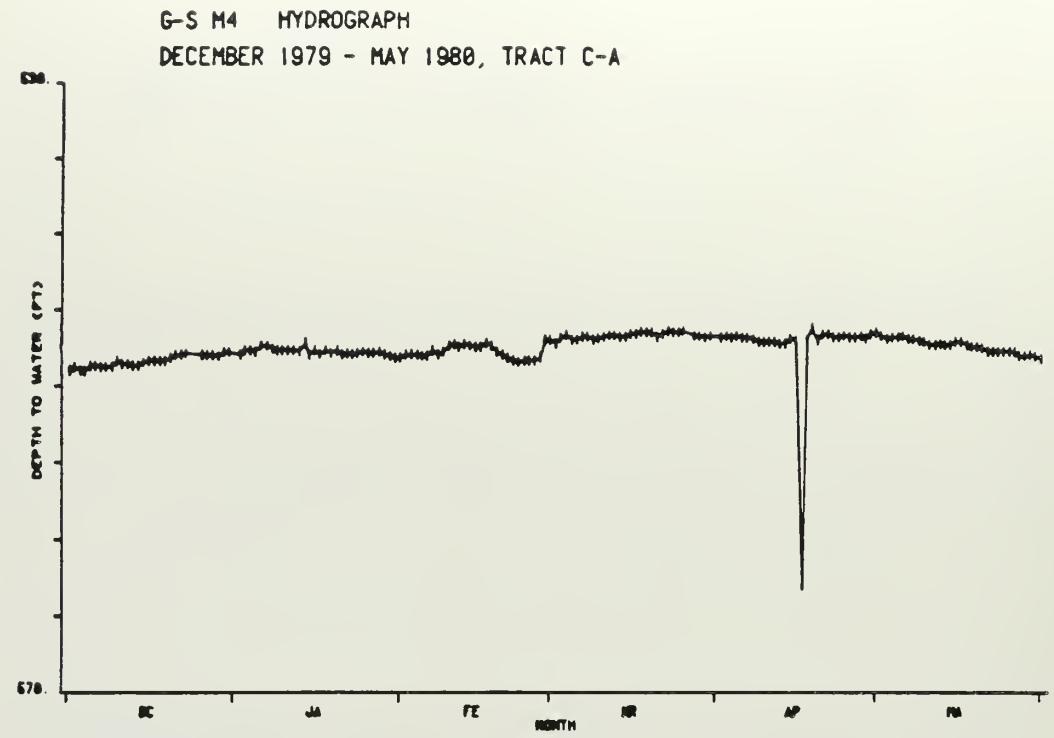

Figure 5-107. Hydrograph of G-S M4, December 1979 - May 1980, Tract C-a

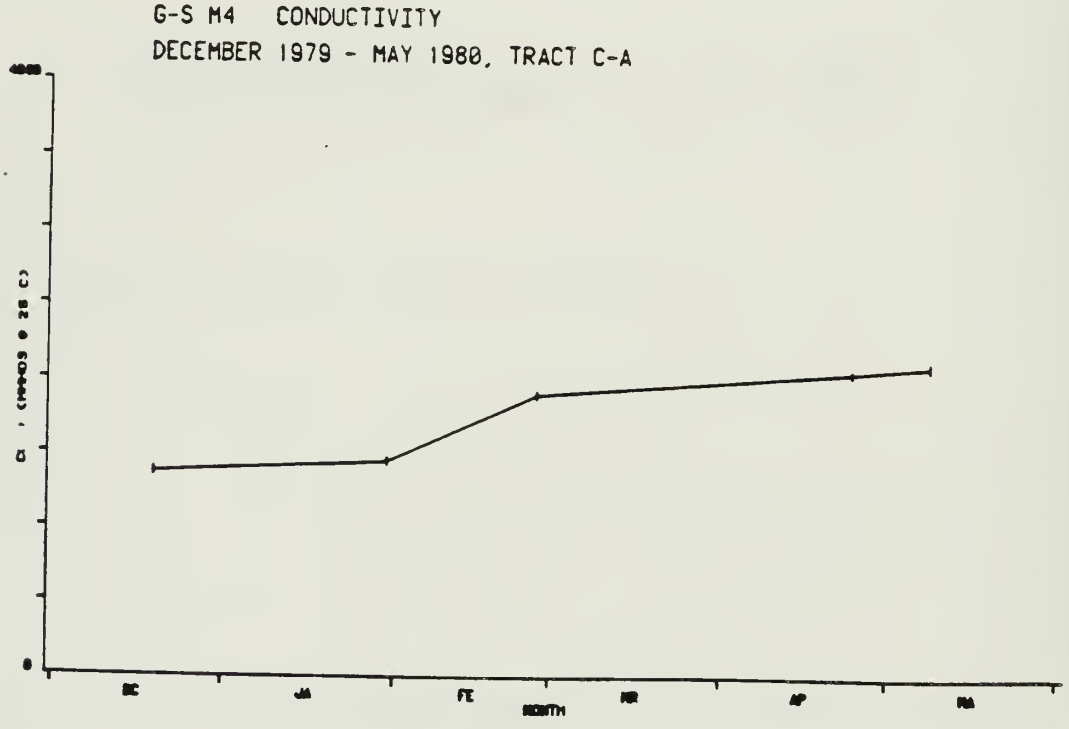

Figure 5-108. Conductivity at G-S M4, December 1979 - May 1980, Tract C-a

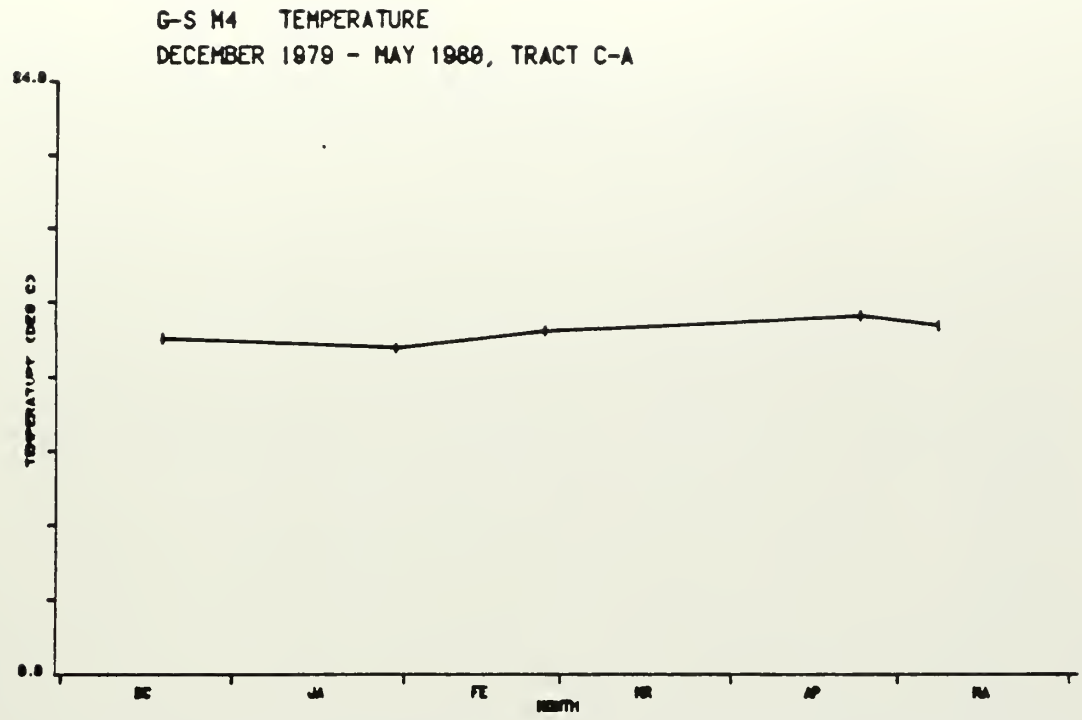

Figure 5-109. Temperature at G-S M4, December 1979 - May 1980, Tract C-a

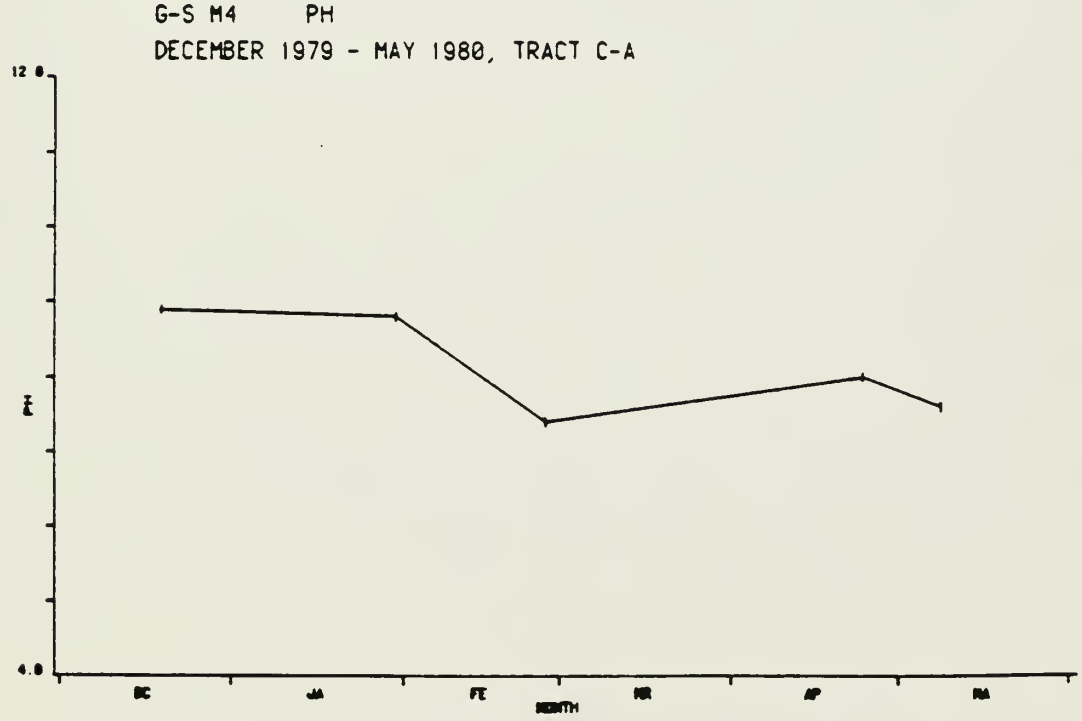

Figure 5-110. pH at G-S M4, December 1979 - May 1980, Tract C-a

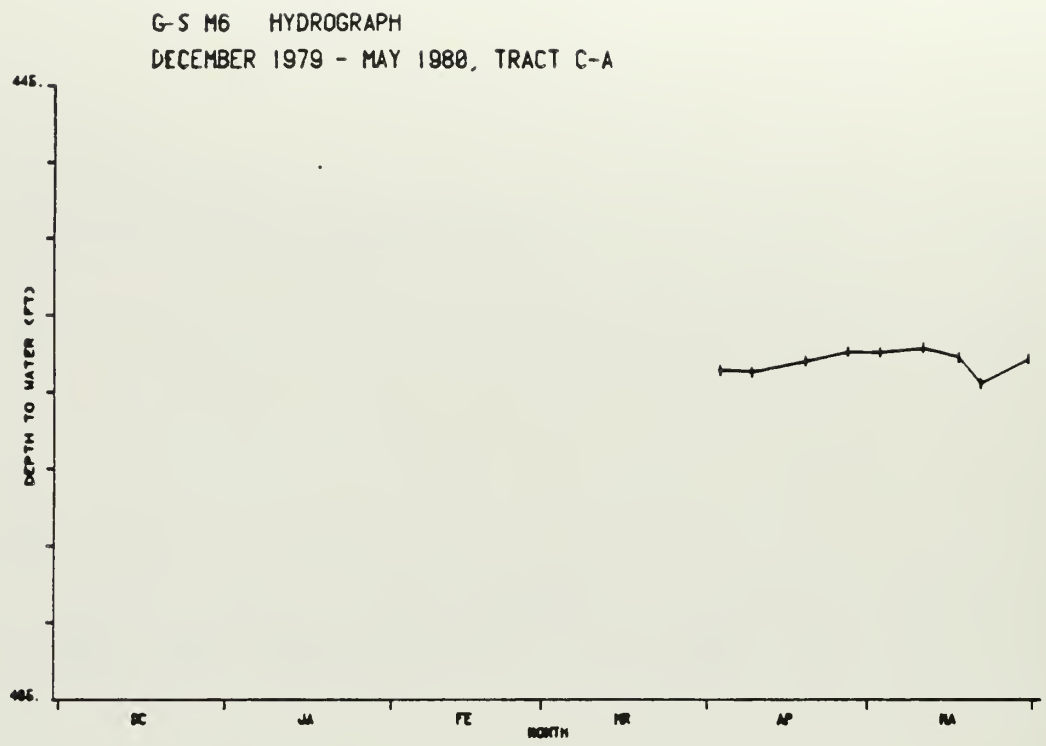

Figure 5-111. Hydrograph of G-S M6, December 1979 - May 1980, Tract C-a

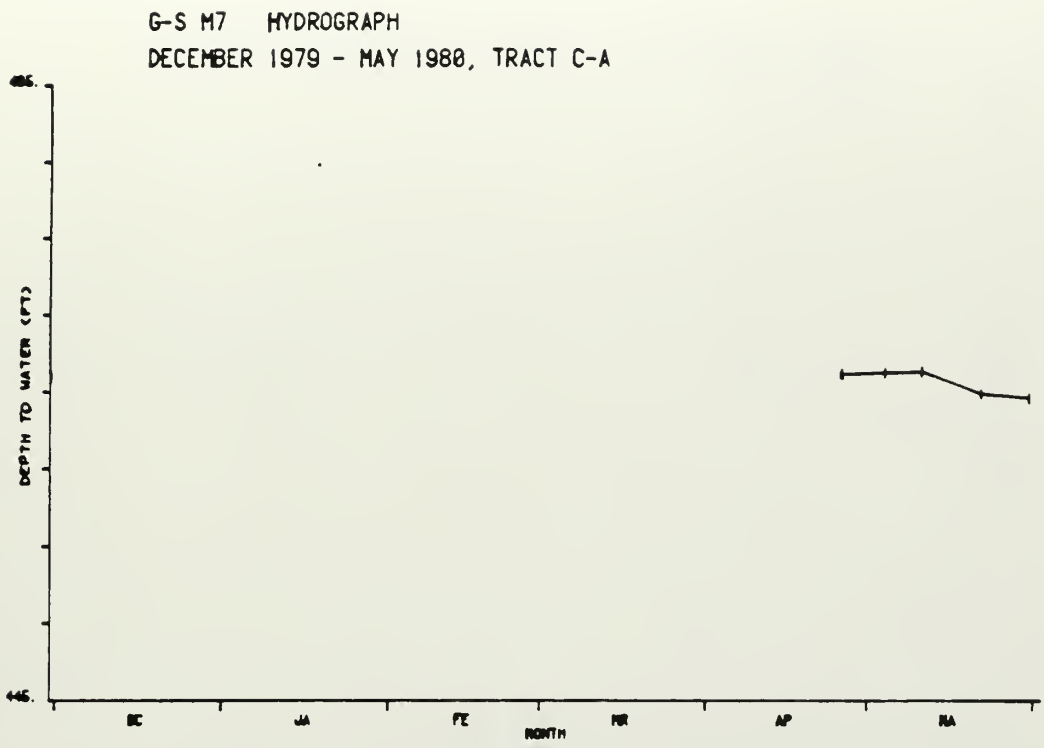

Figure 5-112. Hydrograph of G-S M7, December 1979 - May 1980, Tract C-a

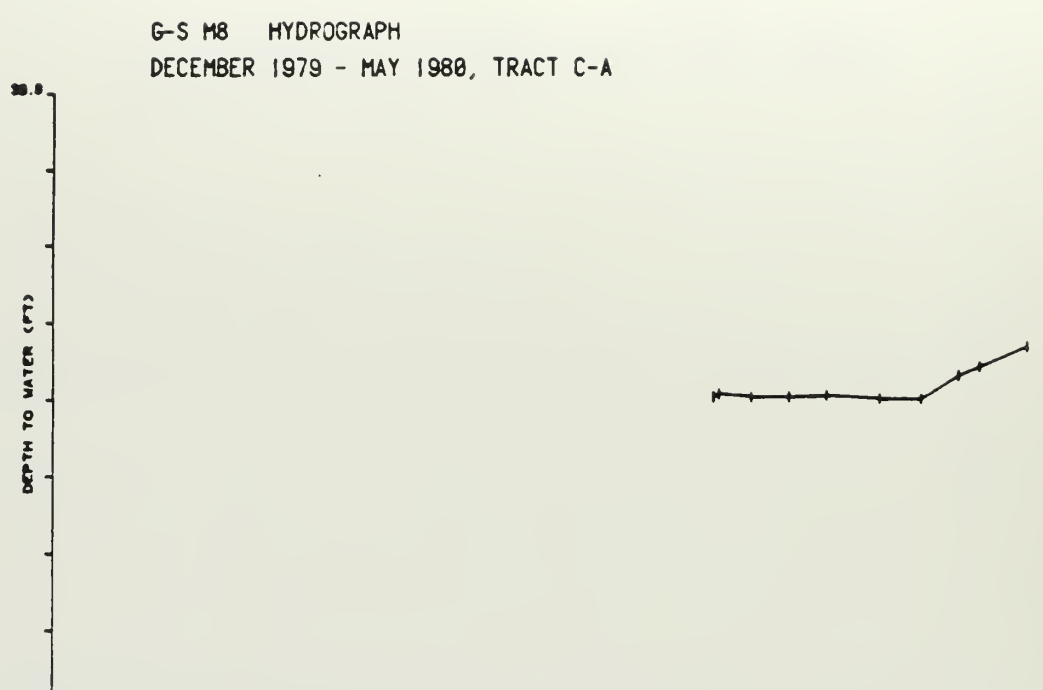

Figure 5-113. Hydrograph of G-S M8, December 1979 - May 1980, Tract C-a

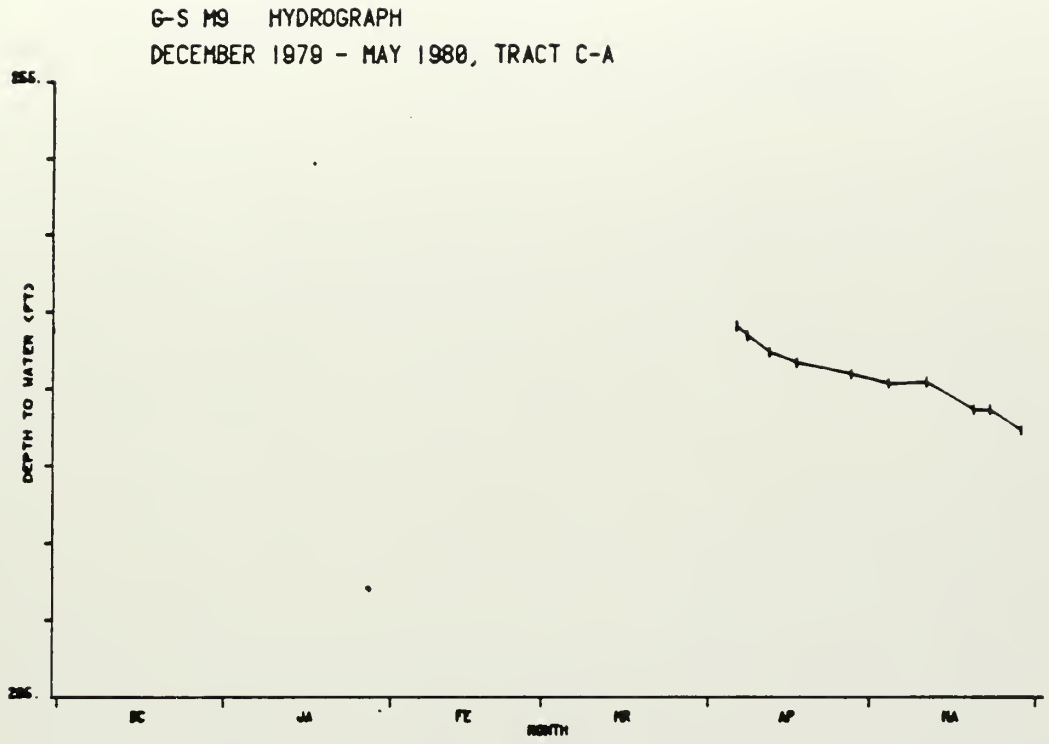

Figure 5-114. Hydrograph of G-S M9, December 1979 - May 1980, Tract C-a

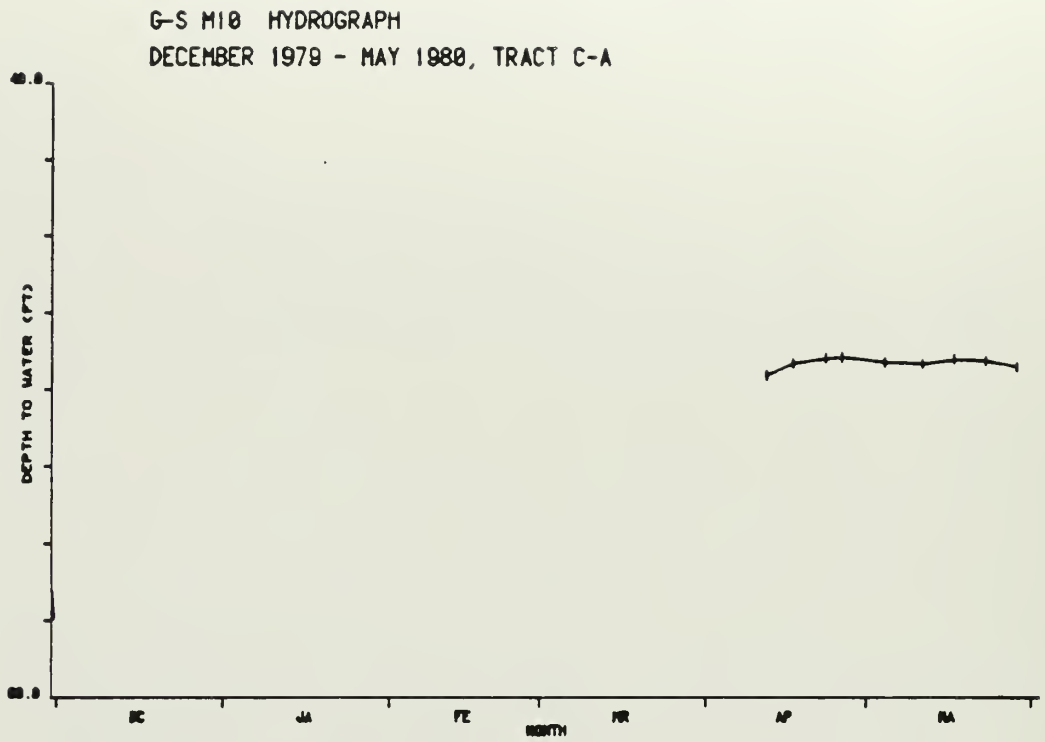

Figure 5-115. Hydrograph of G-S M10, December 1979 - May 1980, Tract C-a

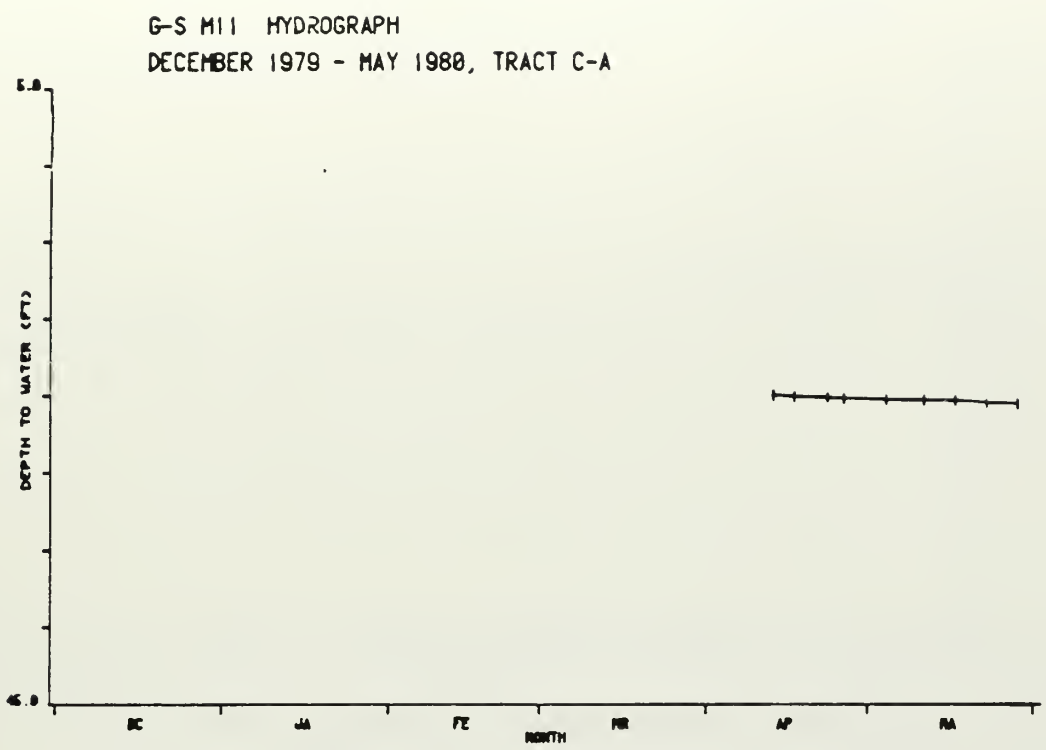

Figure 5-116. Hydrograph of G-S M11, December 1979 - May 1980, Tract C-a

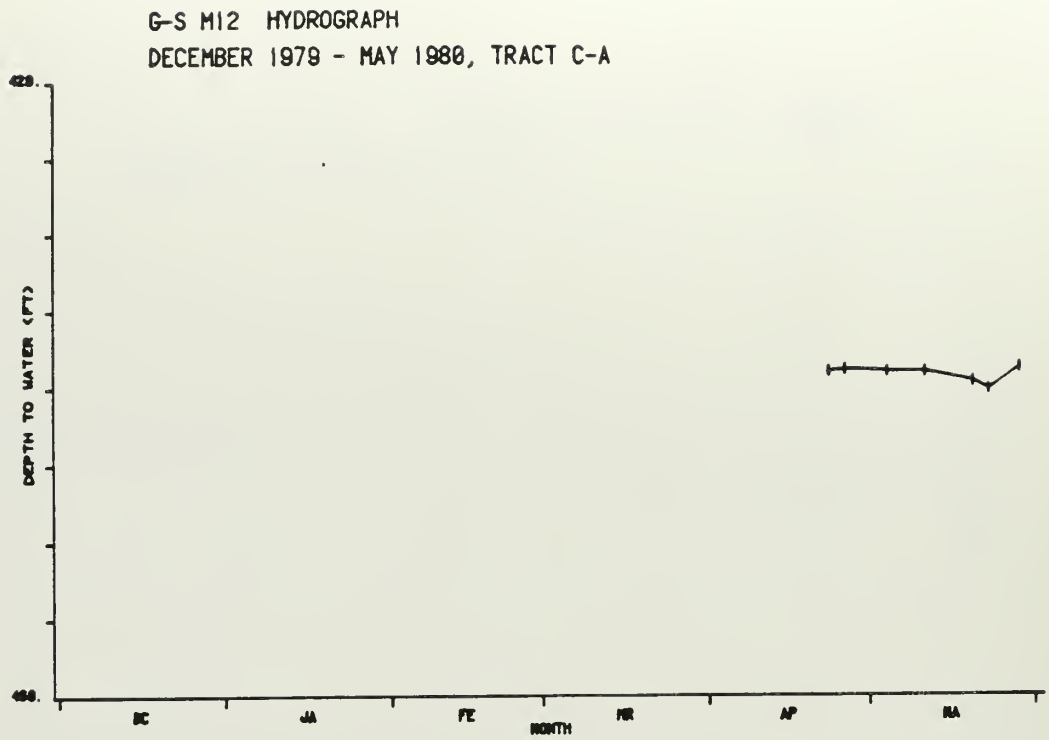

Figure 5-117. Hydrograph of G-S M12, December 1979 - May 1980, Tract C-a

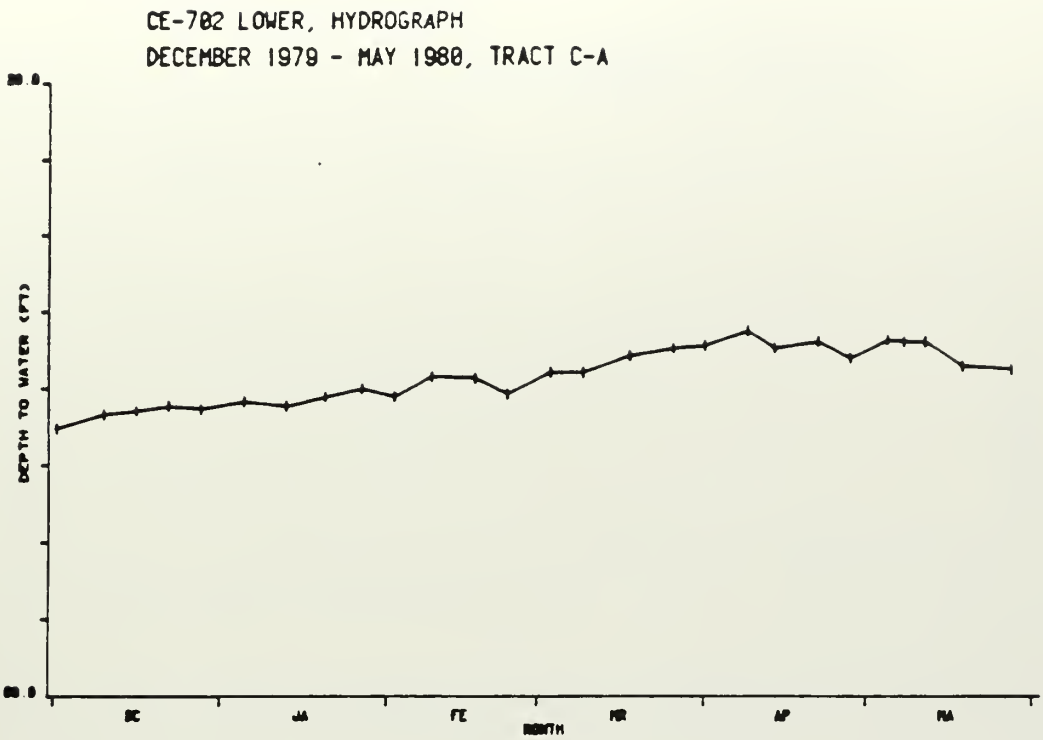

Figure 5-118. Hydrograph of CE-702 Lower, December 1979 - May 1980, Tract C-a

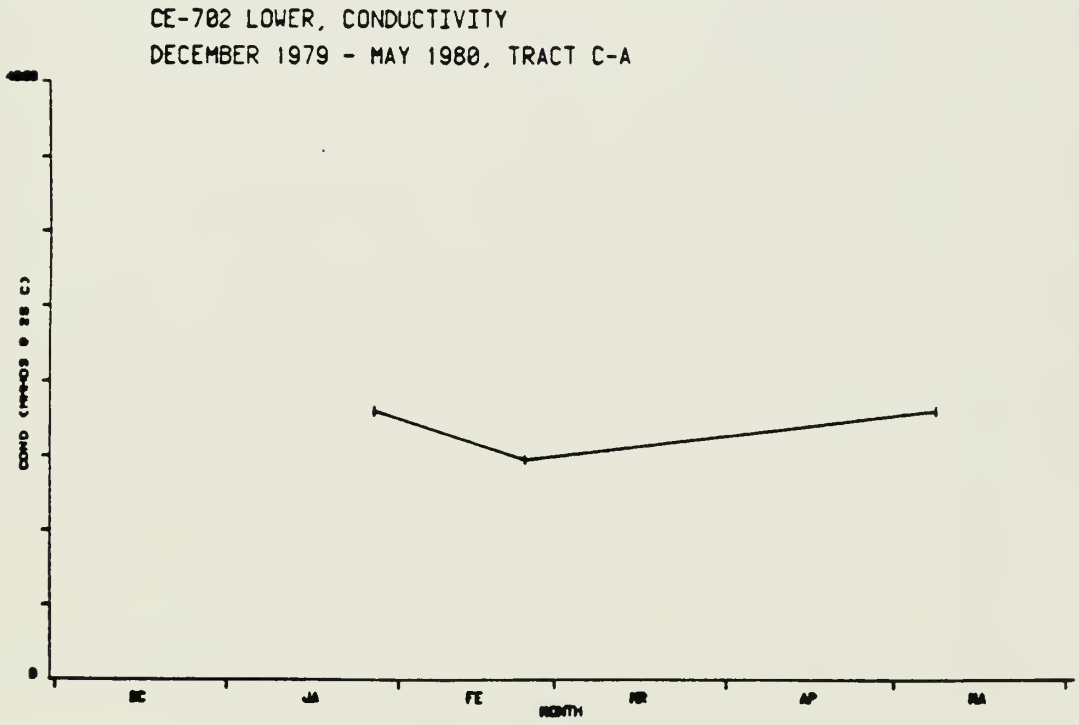

Figure 5-119. Conductivity at CE-702 Lower, December 1979 - May 1980, Tract C-a

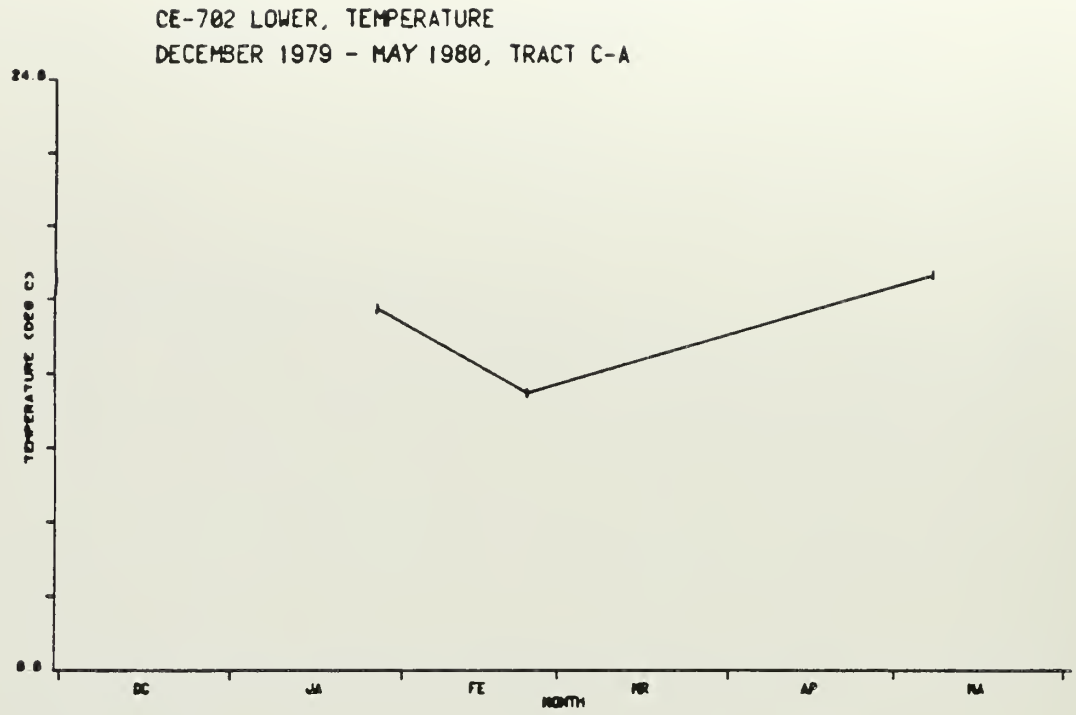

Figure 5-120. Temperature at CE-702 Lower, December 1979 - May 1980, Tract C-a

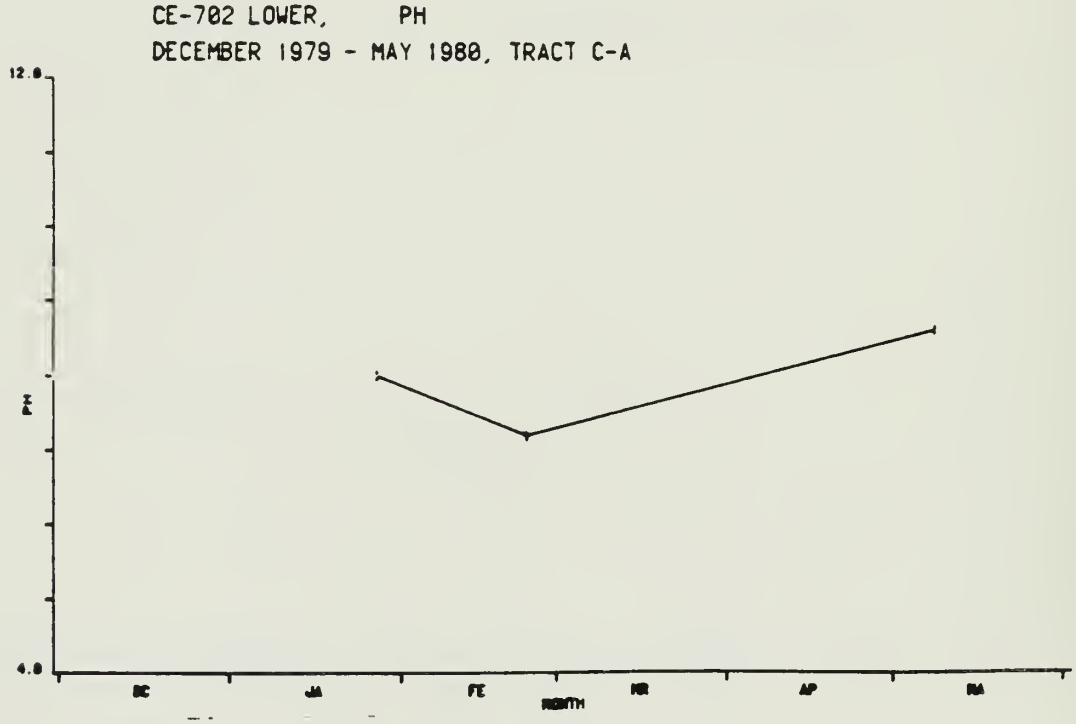

Figure 5-121. pH at CE-702 Lower, December 1979 - May 1980, Tract C-a

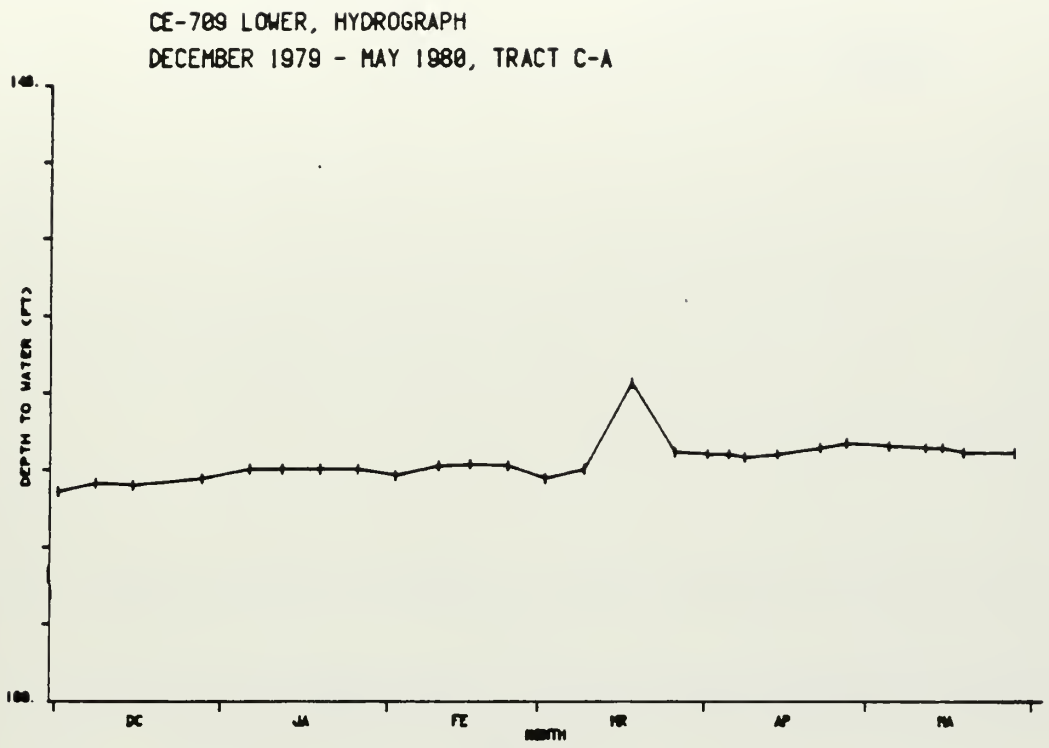

Figure 5-122. Hydrograph of CE-709 Lower, December 1979 - May 1980, Tract C-a

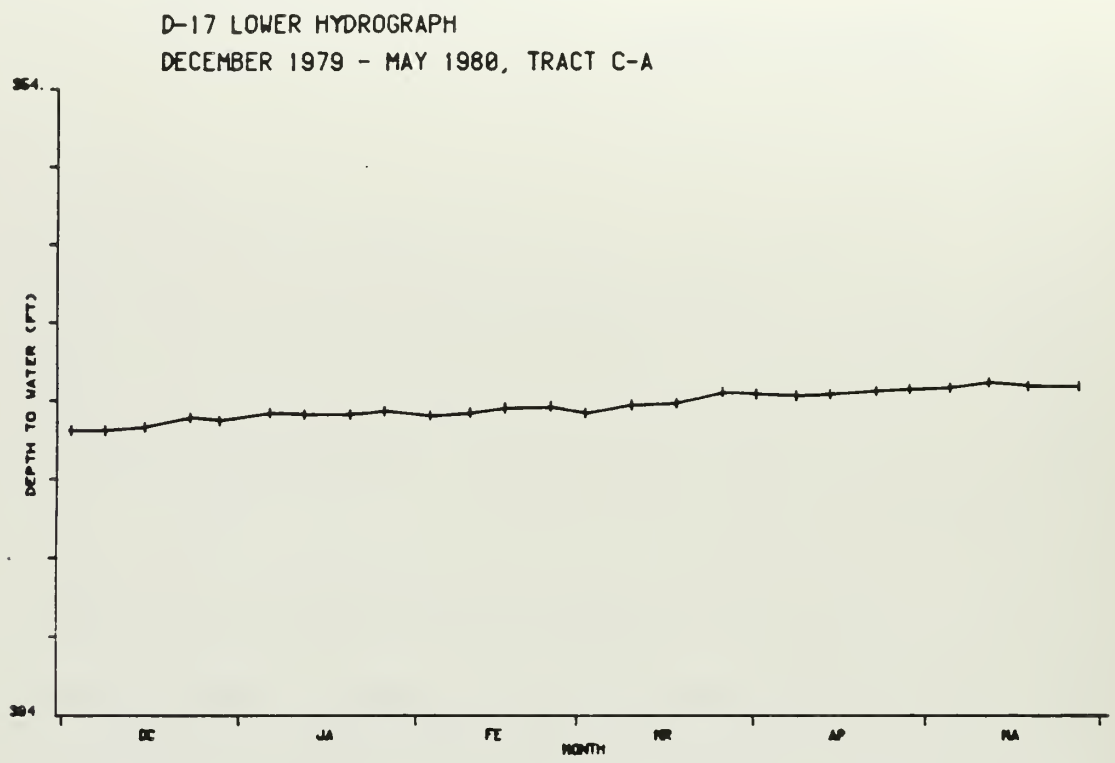

Figure 5-123. Hydrograph of D-17 Lower, December 1979 - May 1980, Tract C-a

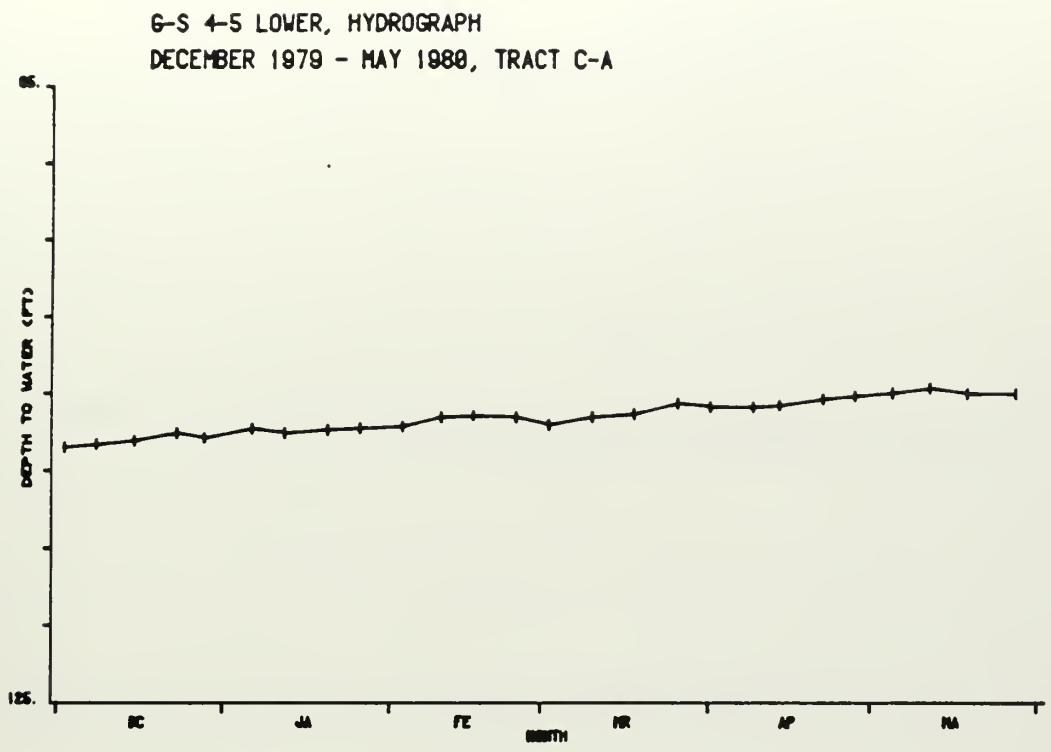

Figure 5-124. Hydrograph of G-S 4-5 Lower, December 1979 - May 1980, Tract C-a

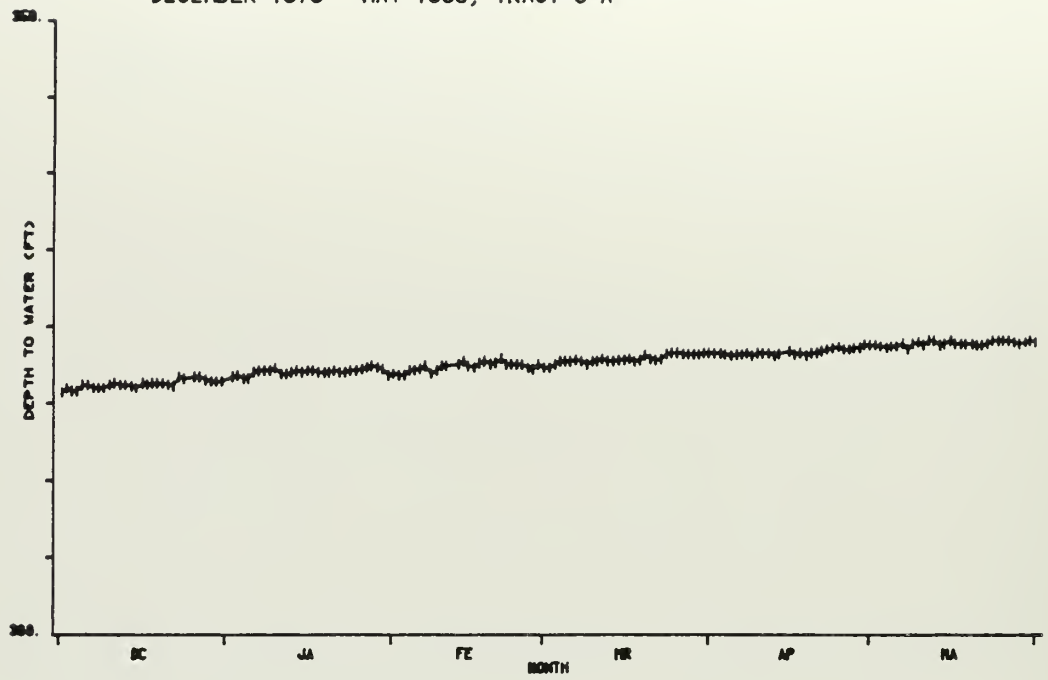

Figure 5-125. Hydrograph of G-S 15 Lower, December 1979 - May 1980, Tract C-a

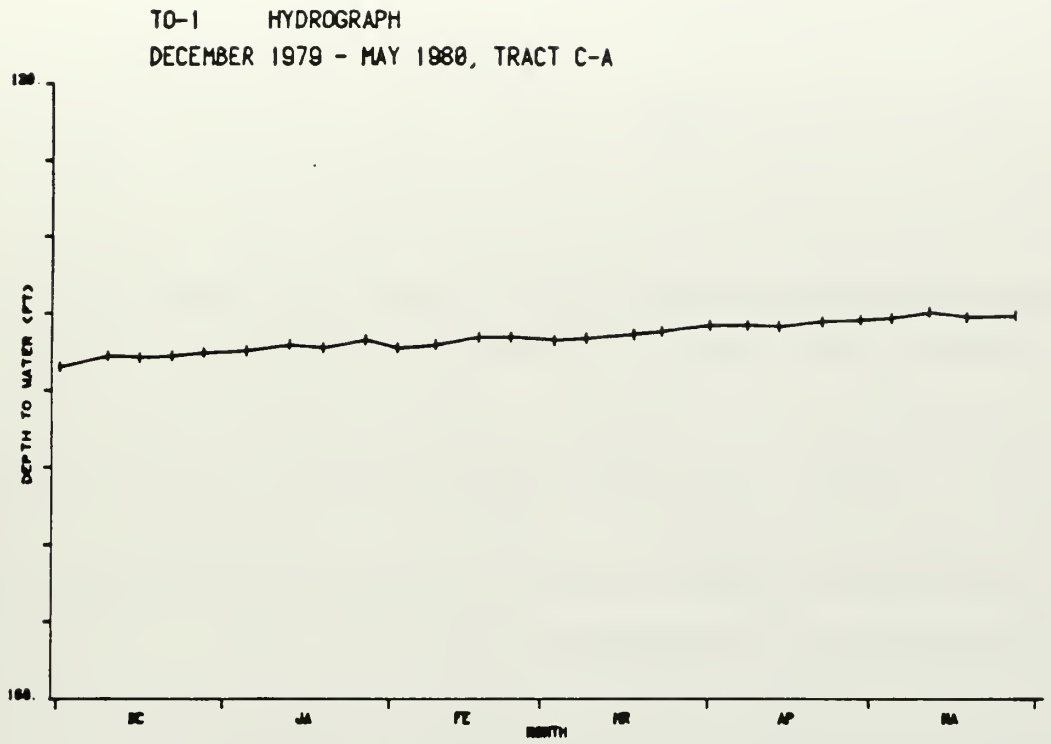

Figure 5-126. Hydrograph of TO-1, December 1979 - May 1980, Tract C-a

Upper aquifer wells - The water level data for AM-2A are plotted on Figure 5-59. The hydrograph for this hole showed that water levels were stable throughout the reporting period.

Water levels for AM-3 are plotted in Figure 5-60. The hydrograph shows very little variation in water level in December 1979 through April 1980, followed by a gradual rise of roughly four feet between May and July. A similar six-foot rise in water level occurred the previous year (1979) between May and July. This rise is attributed to recharge of the upper aquifer from snow melt percolating into the upper aquifer with some time delay.

Physical data for CE-701 are plotted in Figures 5-61 through 5-64. The hydrograph for this hole indicates a gradual decrease in water level as the aquifer is affected by dewatering. Conductivity and temperature show some variation but do not indicate any identifiable trends. The pH level rose somewhat through April but decreased in May.

Physical data for CE-702 are plotted in Figures 5-65 through 5-68. The hydrograph for this hole indicates that the water levels follow reinjection patterns. The sudden water level fluctuations are caused by reinjection shutdown and slowdowns which last only for a few hours, indicating an immediate response to the operations. The conductivity, temperature and pH all remained relatively stable throughout the reporting period.

Physical data for CE-705A are plotted in Figures 5-69 through 5-72. The hydrograph for this hole reflects dewatering activities. A small rise in water level during January is a result of dewatering shutdowns during that month. The sharp drop during the early part of May is a result of the addition of two dewatering wells. The conductivity, temperature, and pH show little variation.

Physical data for CE-707 are plotted in Figures 5-73 through 5-76. The water levels in this hole remain nearly constant from December through mid-February following a pattern set during 1979, but the water levels began to fluctuate dramatically with a net increase in water level from the end of

February through May. CE-707 is located on a Corral Gulch tributary several miles upstream from the mine, and fluctuations are attributed to recharge of the upper aquifer from snowmelt infiltration. Measurements of conductivity, temperature and pH indicate some minor fluctuations, but no trend can be seen.

The hydrograph for CE-708 is shown in Figure 5-77. This hydrograph shows a fairly consistent water level from December through February with a drop in March. From April through May, a major rise in water level occurred. This monitoring station is located west of the graben, and the fluctuation is attributed to response to normal recharge of the upper aquifer.

Physical data for CE-709 upper are shown in Figures 5-78 through 5-81. This monitoring hole is located relatively close to the mining activities on-tract. The hydrograph for this hole shows a gradual decline in water level with minor fluctuations which is a response to the dewatering activities. The conductivity graph does not show an identifiable correlation of water quality with the changing water table. The conductivity appears to have increased with time with some fluctuations throughout the reporting period. The temperature fluctuated ,as did the pH, with peaks in April.

The hydrograph for GS-1 is shown on Figure 5-82. This monitoring station is located near the western border of the tract, some distance from the dewatering operation. The water level shows a gentle decline from December through March followed by a gradual rise. This is attributed to natural seasonal recharge with minimal influence from dewatering.

The hydrograph for G-S 2-3 is shown on Figure 5-83. The steady decline in water level follows an unbroken trend from June, 1979. This monitoring hole is within the cone of depression caused by the dewatering operation. One anomalous reading in April is be attributed to measurement error.

The physical data for G-S 9 are given in Figure 5-84 through 5-87. This hydrograph shows a steady decline in water level through April followed by a drastic rise in May. The conductivities, temperatures and pH values fluctuated throughout the reporting period.

The physical data for G-S 10 are shown in Figures 5-88 through 5-91. G-S 10 responded only to dewatering during the early portion of the project; however, since reinjection was reinitiated in September 1979, G-S 10 water levels have risen through April. The decline in May is attributed to the increased dewatering in Box Elder Gulch. Conductivities and temperatures all remained relatively stable. The pH plot showed a trend similar to previously described wells but the variations are more pronounced.

Hydrographs for G-S 12 and G-S 13 are shown on Figures 5-92 and 5-93 respectively. These holes are located in the graben in the southeast corner of the tract and water levels in both holes show little variation. The apparent six-foot rise during March at G-S 12 is attributed to measurement error.

Physical data for G-S 15 upper are plotted in Figures 5-94 through 5-97. The hydrograph for this hole shows a very gradual rise after the initial affect of mine dewatering during 1979. Fluctuations in conductivity are considered to indicate natural variations in groundwater quality in this area. Temperature and pH fluctuated during the reporting period.

Physical data for G-S M1 are plotted in Figures 5-98 through 5-101. After a steady decline during 1979, a result of the influence of dewatering, the water has shown little variation except for an immediate four foot jump at the end of February. Conductivity, temperature, and pH fluctuate, but no trend is apparent.

Water level data for G-S M2 are shown on Figure 5-102. This well is far from mining activities and recharge area that the water levels are steady.

Physical data plots for G-S M3 are shown in Figures 5-103 through 5-106. This well is also removed from tract activities and the hydrograph for this hole indicates a constant water level. Conductivity and pH remained steady but temperature fluctuated during the reporting period.

The plots of physical data for G-S M4 are shown on Figures 5-107 through 5-110. The water levels in this hole are relatively stable throughout the reporting period, with the exception of one day in April. This point is attributed to a measurement error. Conductivity and pH fluctuated but temperatures remained fairly constant.

During the reporting period December 1979 through May, 1980, seven deep aquifer monitoring wells (G-S M6 to G-S M12) were drilled and completed. Water levels were measured during April and May, and the hydrographs are shown on Figures 5-111 through 5-117. M6, M7, M10, M11, and M12 have remained stable; M8 increased and M9 decreased.

In general, water levels in the upper aquifer near the mine responded to dewatering and reinjection. Natural recharge affected those along the north and west portions of the tract. Wells in the southeast corner of the tract remained stable. Conductivity fluctuated but no major trend could be established for the tract as a whole. Some temperatures exhibited a seasonal trend which is probably a local well response to the atmospheric temperature fluctuations. Values of pH remained relatively constant although some holes fluctuated, showing a peak in April.

Lower aquifer wells - The physical data for CE-702 lower is shown in Figures 5-118 through 5-121. The water level in this well exhibits a very gradual rise. Conductivity, temperature, and pH fluctuated, with the January and May readings nearly identical and a low reading in February.

The hydrograph for CE-709 lower is shown in Figure 5-122. Except for one anomalous reading in March, the water levels in this hole are relatively stable. The anomalous reading is attributed to a measurement error.

The hydrographs for D-17, G-S 4-5 lower, G-S 15 lower, and TO-1 are plotted on Figures 5-123, 5-124, 5-125, and 5-126, respectively. Water levels in these holes show a very slight increase throughout the reporting period.

The water levels in the lower aquifer have not responded appreciably to dewatering; however, since September, a few of them appear to have responded to reinjection in the northeast corner of the tract. Fluctuations of physical parameters are attributed to the presence of upper aquifer water near the boreholes that entered the lower aquifer before bridges were placed between the aquifers.

b. Chemical parameters - Water quality data for upper and lower aquifer wells are reported in Appendix 5-2.2.

5.3 DEVELOPMENT ACTIVITIES MONITORING

1. Objectives

The objective of the development activities monitoring program is to determine the direct impacts of specific activities associated with the oil shale development on Tract C-a. The monitoring stations associated with this program have been installed as needed, when a particular activity, such as dewatering, commenced. The development activities monitoring stations are located on-tract, in the vicinity of or downstream from development activities. A location of these monitoring stations is shown on Map 1 (MDP Monitoring Report 4).

2. Methods

The development activities which are being monitored as part of this program are all associated with the dewatering of the oil shale aquifer. The functional dewatering wells were monitored for physical and chemical characteristics. The holding ponds for the dewatering water were also monitored for physical and chemical characteristics. Four piezometers were installed to detect any seepage from the East Retention Pond.

There are four reinjection wells: G-S 4-5, G-S 6, TO-2, and TO-3 of which TO-2 was on standby to evaluate recycling to the mine. Physical and chemical parameters were analyzed on samples taken from these wells during the reporting period. In addition, two springs were monitored to detect any possible impacts on surface water from the reinjection. One of these springs is located immediately upstream from Box Elder flume, and the other, Miller Spring, is located between Station D and the road. Discharges are measured from these springs, and physical parameters are determined from samples taken from them.

Water that is not reinjected, recharged or used consumptively is discharged. Five surface stations are located in Corral Gulch and Yellow Creek to monitor

the effects of the discharge. Water levels or flows were measured at these points and physical parameters were determined from samples taken at each point. Water quality data for Development Activities monitoring are included in Appendix 5-3.

3. Results and Discussion

a. Dewatering - Mine dewatering was accomplished through the use of mine sumps and three dewatering wells (D-5, D-6, D-8). Two dewatering wells (D-6 and D-8) were drilled and completed during this reporting period, and two other wells (D-7 and D-9) were drilled, but not completed. Figure 5-127 is a graph of total water production from the sumps and wells. The total water production generally ranged from 1400 to 1600 gpm prior to the installation of the new dewatering wells. Since then water production has generally ranged from 1700 to 2000 gpm.

These flows are monitored as they are discharged to the West Retention Pond. Physical data for D-5 are plotted in Figures 5-128 through 5-130. Conductivity was stable at about 1400 micromhos. Temperature was fairly stable at about 16 C, and pH fluctuated between 7.5 and 8.0. Physical data for D-6 and D-8 are plotted in Figures 5-131 through 5-136. Since D-6 and D-8 began pumping, values of conductivity, temperature and pH have been very similar to those for D-5.

b. Ponds - Two holding ponds on Tract C-a are utilized for temporary and permanent storage of various effluents associated with the development activities. Mine seepage water was pumped into the West Retention Pond. Well production and surface runoff from the mine area were also collected in the West Retention Pond where the water is stored until needed for reinjection, discharge to Corral Gulch, or consumptive use (fire, storage, and drilling water). The East Retention Pond is a holding pond used for sewage blow down and blow down to be produced from future retort operations.

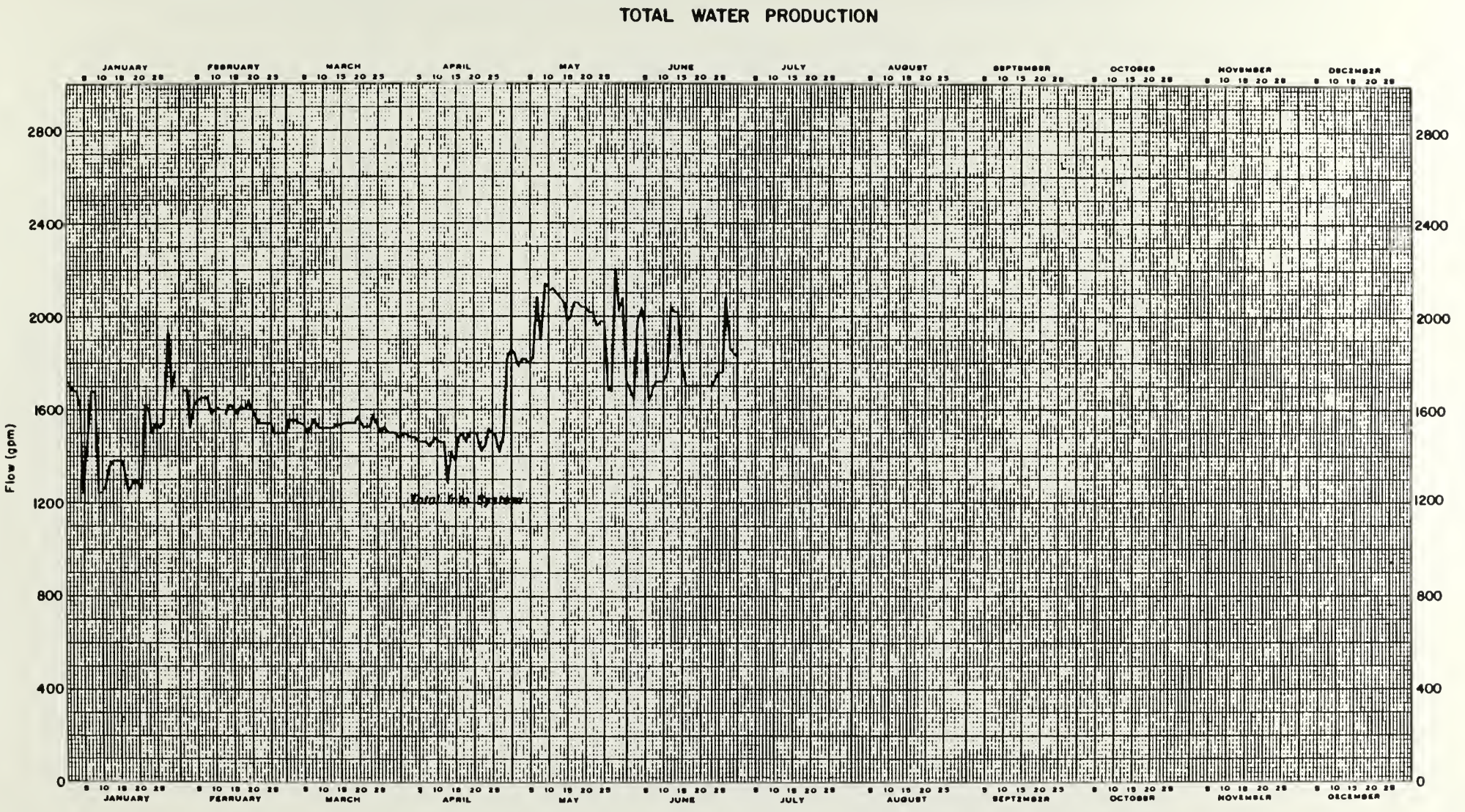

Figure 5-127. Total Water Production from the Sumps and Wells, December 1979 - May 1980, Tract C-a

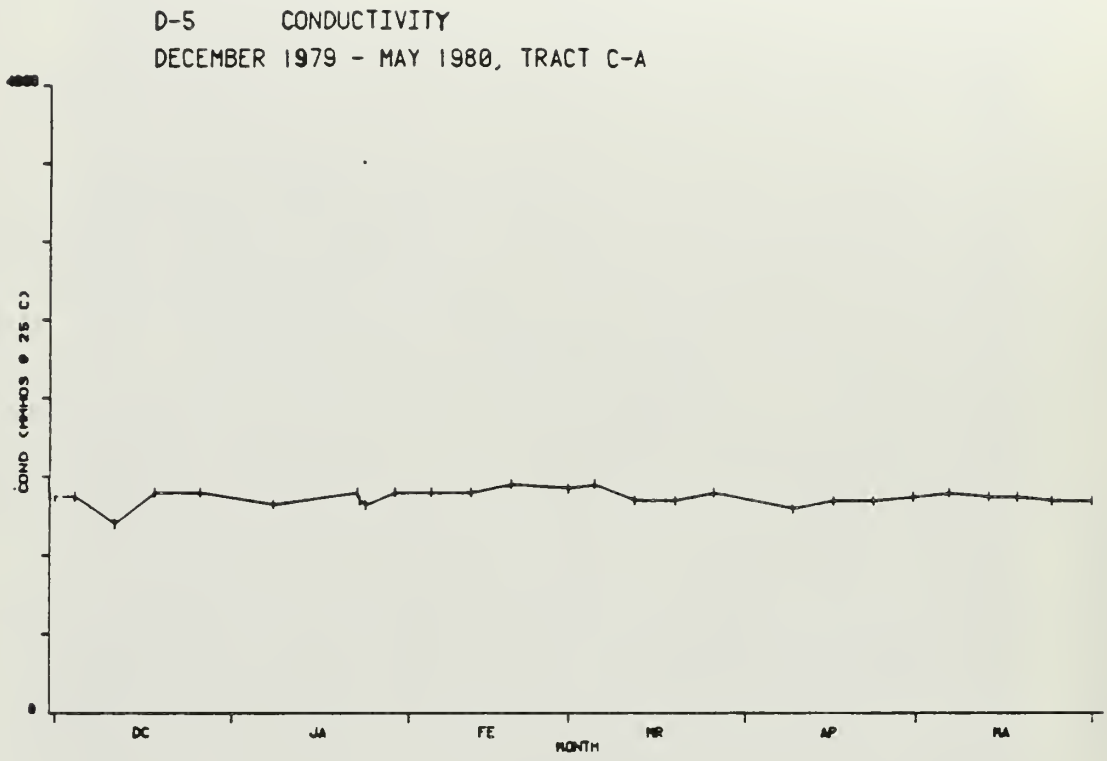

Figure 5-128. Conductivity at D-5, December 1979 - May 1980, Tract C-a

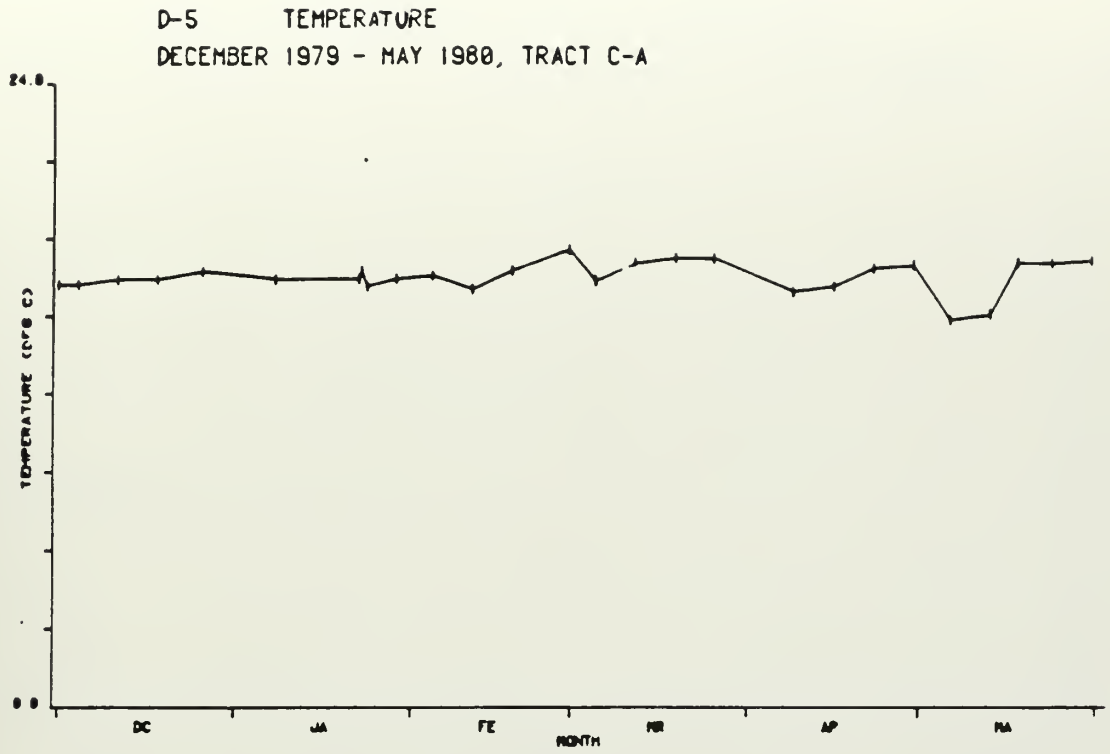

Figure 5-129. Temperature at D-5, December 1979 - May 1980, Tract C-a

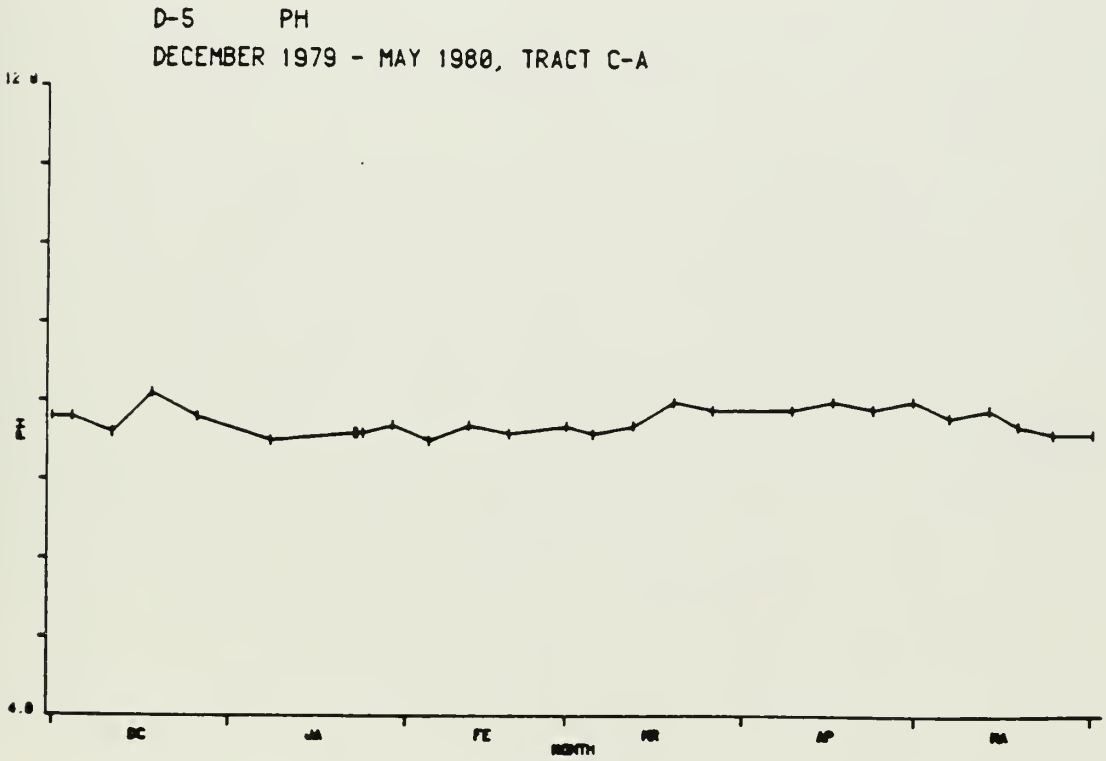

Figure 5-130. pH at D-5, December 1979 - May 1980, Tract C-a

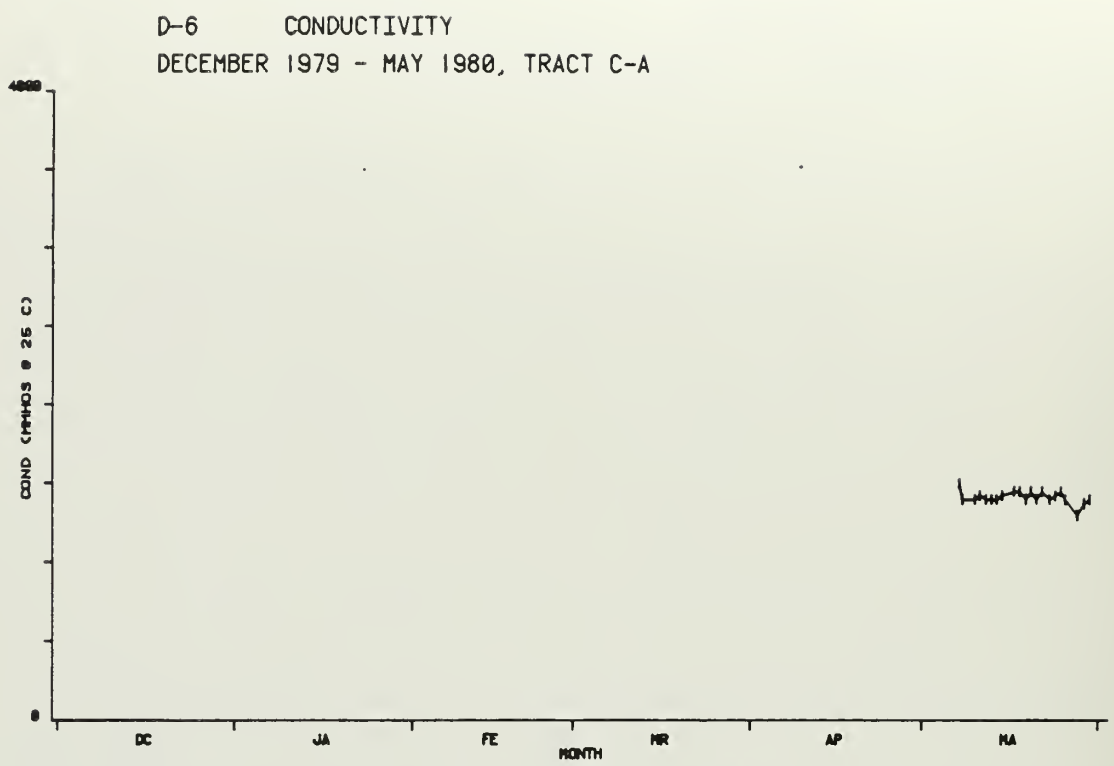

Figure 5-131. Conductivity at D-6, December 1979 - May 1980, Tract C-a

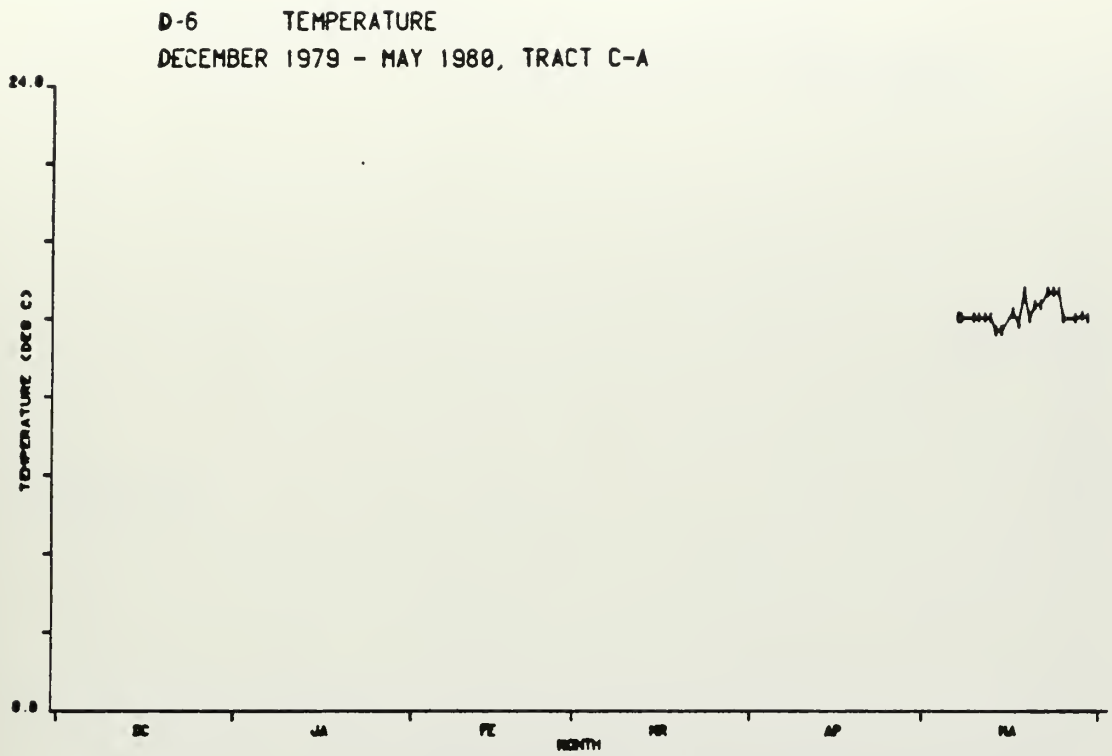

Figure 5-132. Temperature at D-6, December 1979 - May 1980, Tract C-a

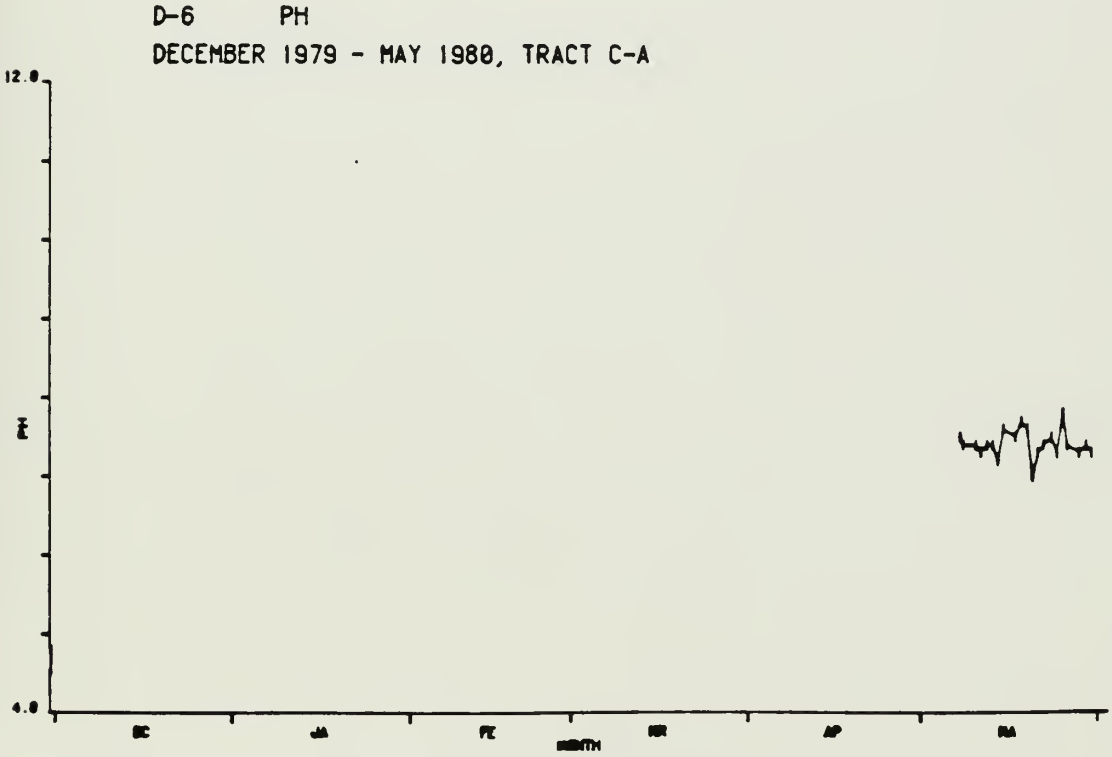

Figure 5-133. pH at D-6, December 1979 - May 1980, Tract C-a

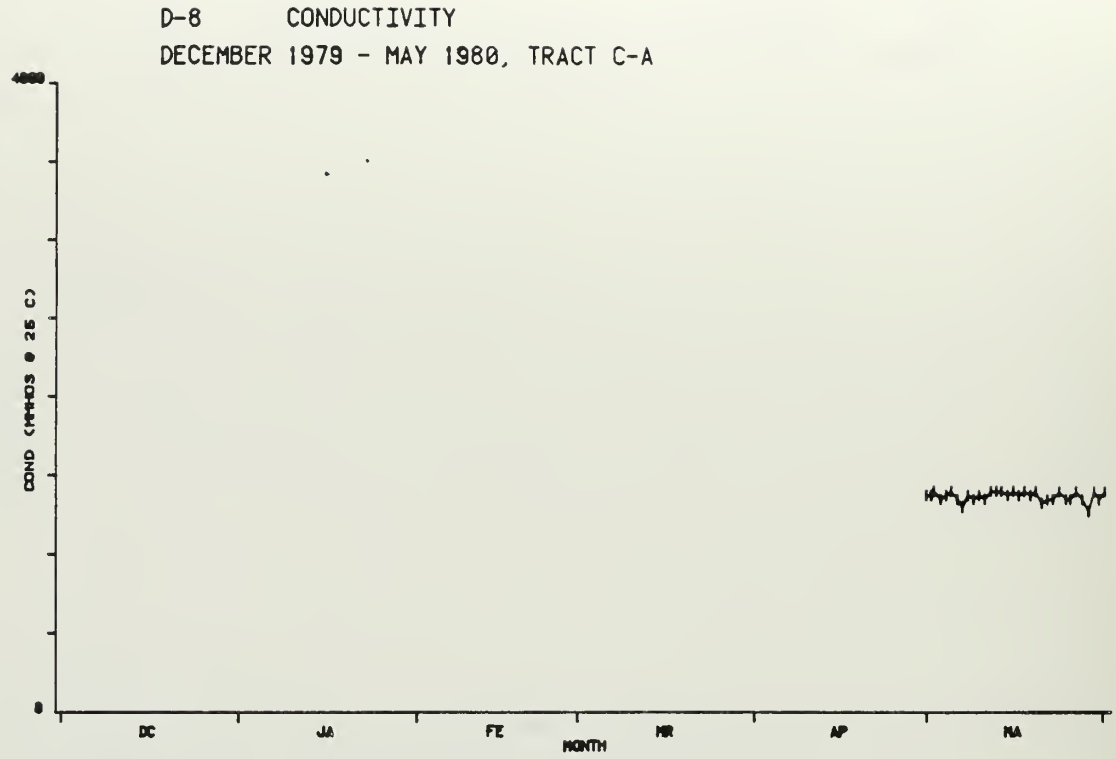

Figure 5-134. Conductivity at D-8, December 1979 - May 1980, Tract C-a

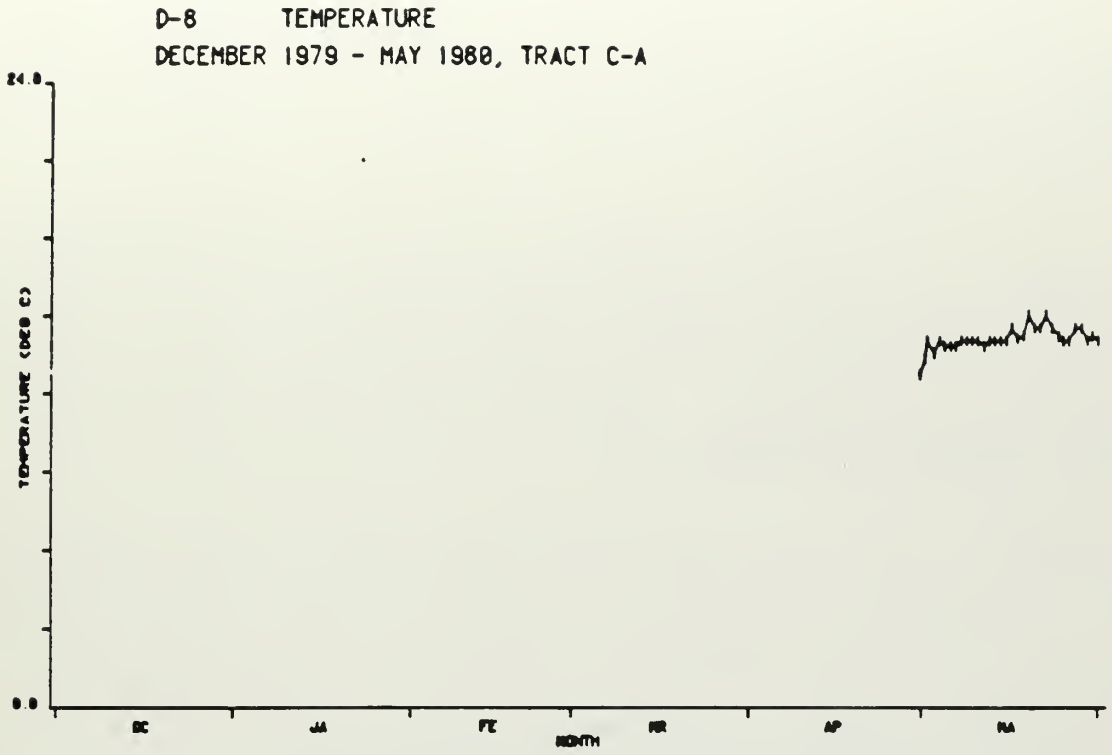

Figure 5-135. Temperature at D-8, December 1979 - May 1980, Tract C-a

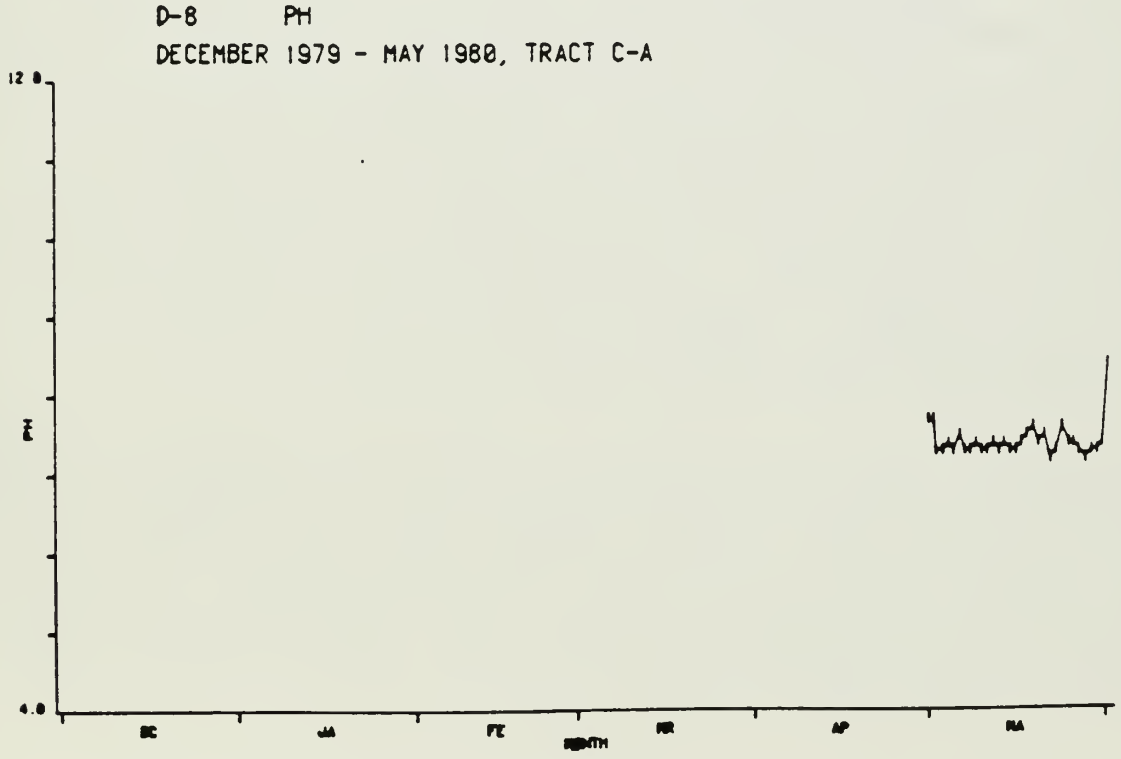

Figure 5-136. pH at D-8, December 1979 - May 1980, Tract C-a

Plots of physical data for the West Retention Pond are shown in Figures 5-137 through 5-139. The conductivity was stable at 1400 micromhos; temperature fluctuations are attributed to the atmospheric effect of variations in temperatures; pH remained relatively constant at about 8.0 although towards the end of May, a rise occurred.

Physical data for East Retention Pond are plotted in Figures 5-140 through 5-142. All three parameters exhibited sudden changes that are attributed to pond turnover. Conductivity decreased radically in late January and then increased slightly in late April. Temperature and pH both changed at the same time, but inversely to conductivity.

Four piezometers were located downstream from the East and West Retention Ponds for the purpose of monitoring pond seepage. Water level observations were taken in each of the piezometers during the reporting period. Piezometers #2 and #3 were dry. Piezometers #1 and #4 sporadically contained water which is attributed to spring snowmelt and rainfall. The physical data for this water are shown in Figures 5-143 through 5-150.

c. Composite reinjection - Water was reinjected from the West Retention Pond into the upper aquifer through Wells No. G-S 4-5, G-S 6, and TO-3. Total reinjection is shown in Figure 5-151. Almost all of the water produced through April (an average of about 1500 gpm) was reinjected. In May reinjection capacity decreased about 300 gpm and surface discharge was necessary. Physical data for the water which was reinjected are shown in Figures 5-152 through 5-154. Conductivity and pH were almost identical to West Pond measurements. Temperature was very similar to West Pond measurements, but showed some difference in magnitude.

Miller Spring is monitored to measure the effects of reinjection. The hydrograph for Miller Spring is shown in Figure 5-155. Miller Spring has a very low flow rate, and the fluctuations on the hydrograph may be due to the level of precision of measurement, as well as actual fluctuations. A slight decrease in flow through the winter months with a slight increase in spring is

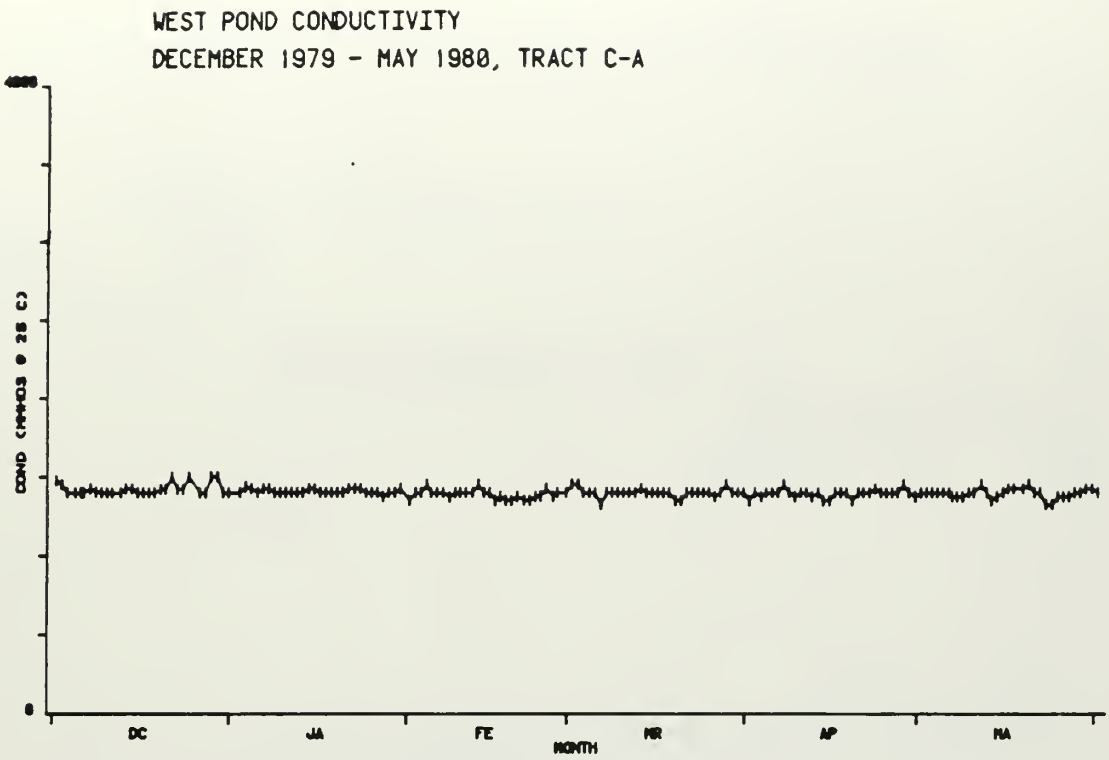

Figure 5-137. Conductivity at West Retention Pond, December 1979 - May 1980, Tract C-a

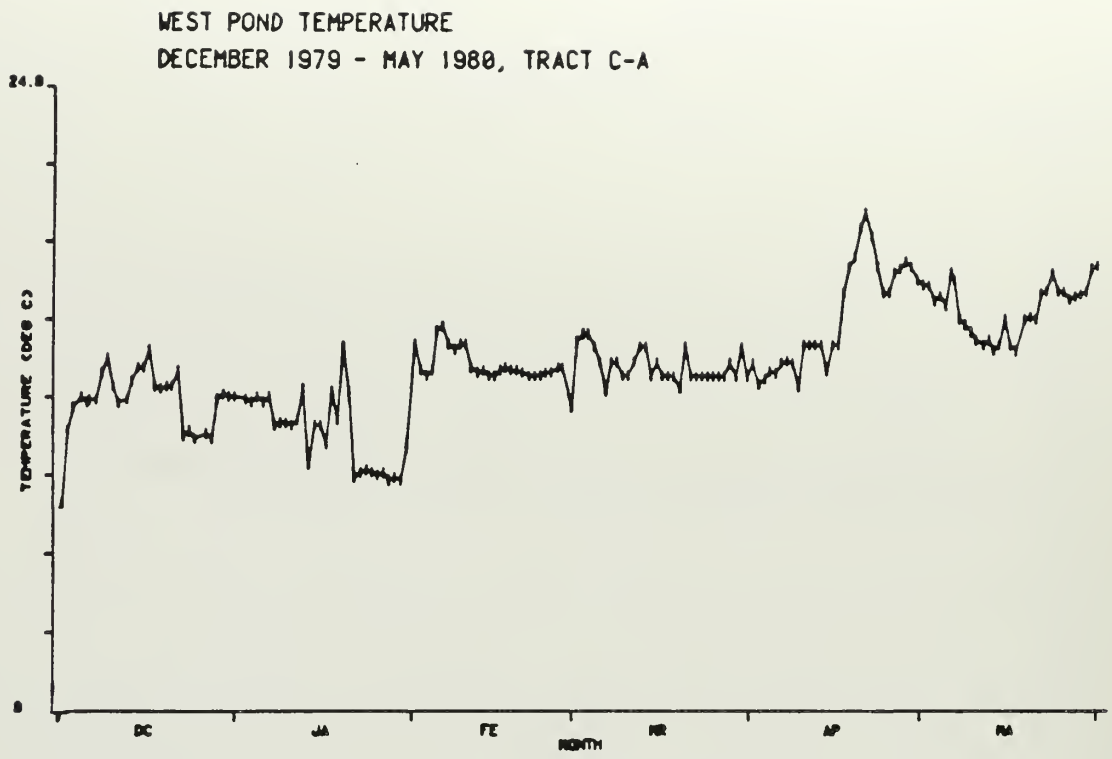

Figure 5-138. Temperature at West Retention Pond, December 1979 - May 1980, Tract C-a

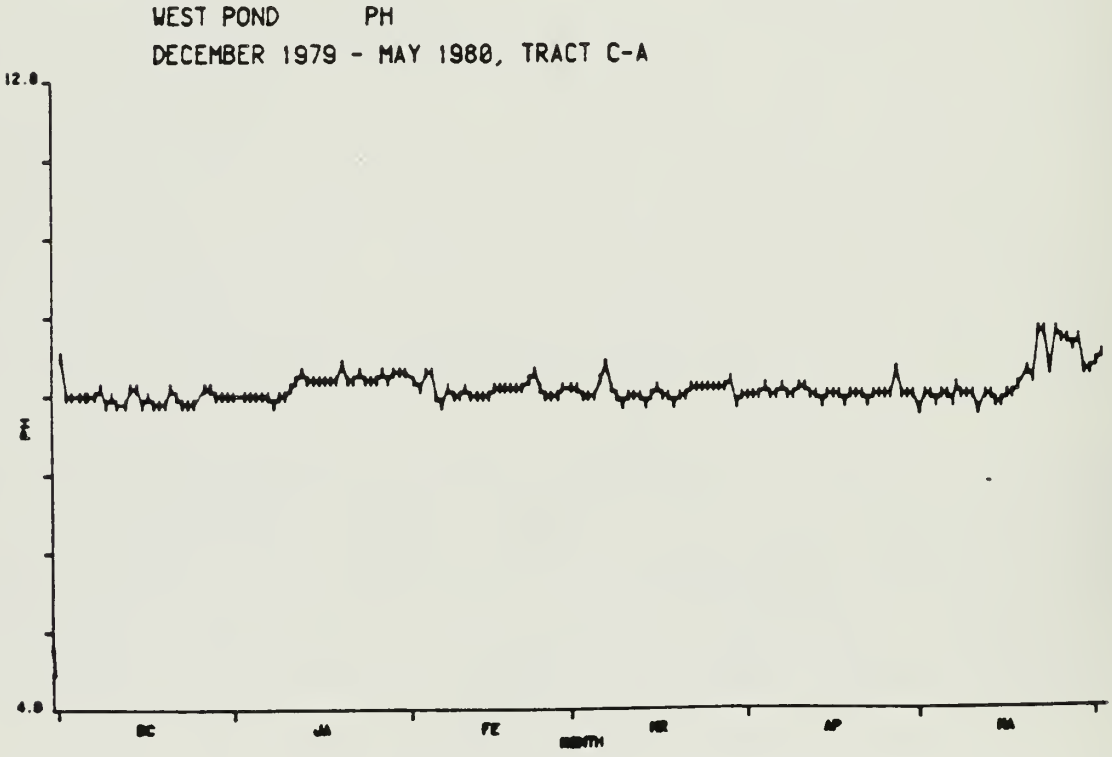

Figure 5-139. pH at West Retention Pond, December 1979 - May 1980, Tract C-a

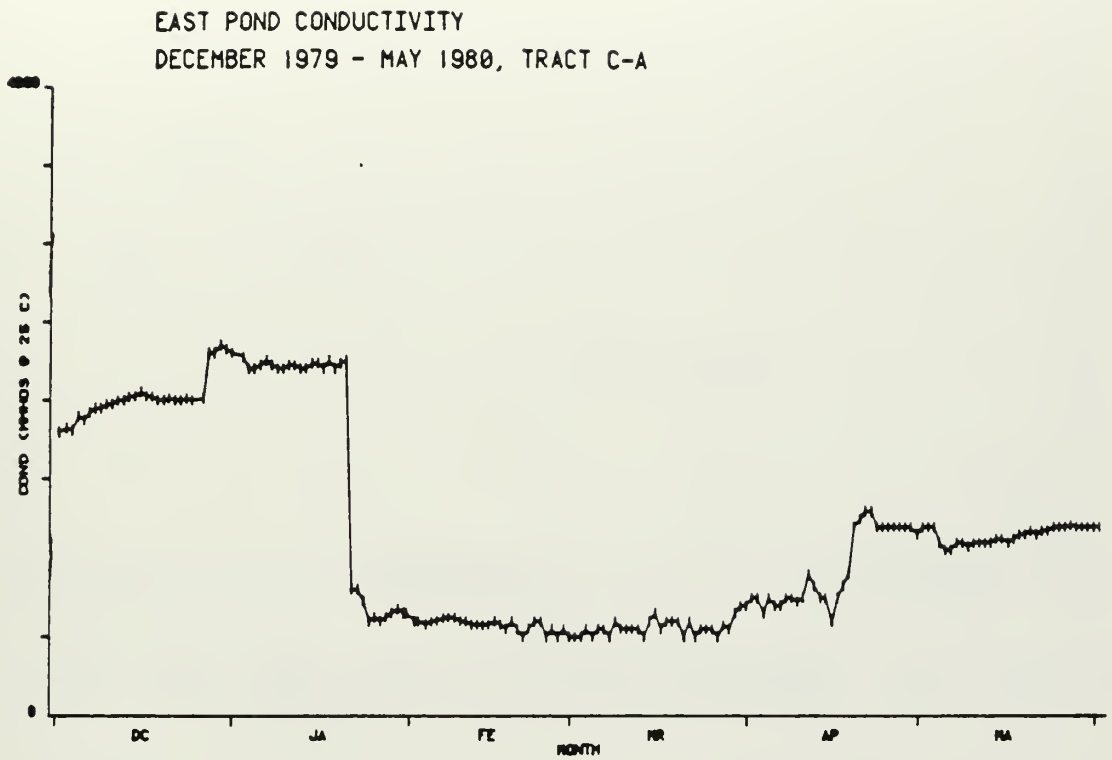

Figure 5-140. Conductivity at East Retention Pond, December 1979 - May 1980, Tract C-a

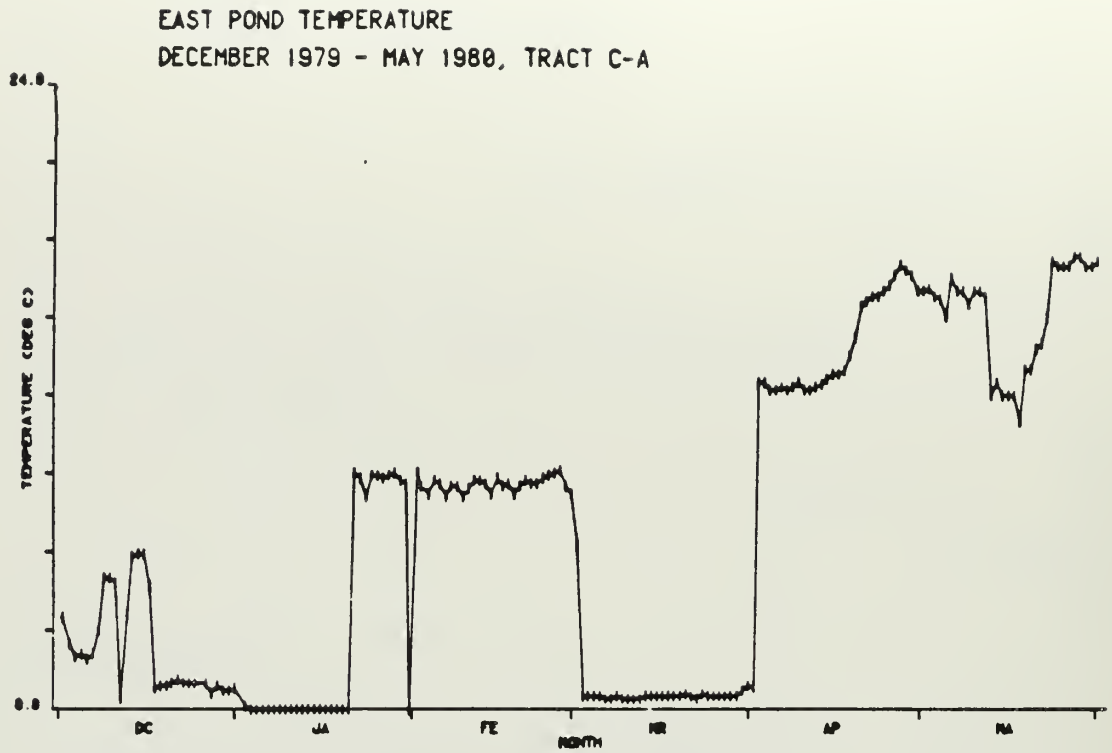

Figure 5-141. Temperature at East Retention Pond, December 1979 - May 1980, Tract C-a

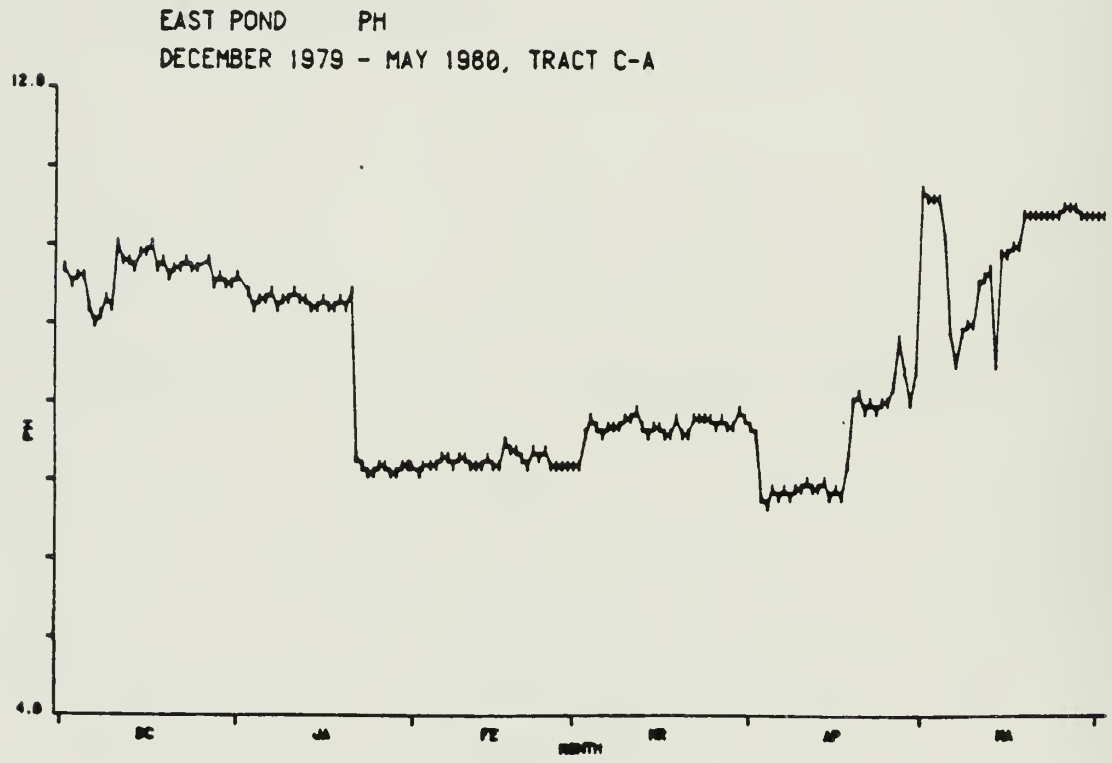

Figure 5-142. pH at East Retention Pond, December 1979 - May 1980, Tract C-a

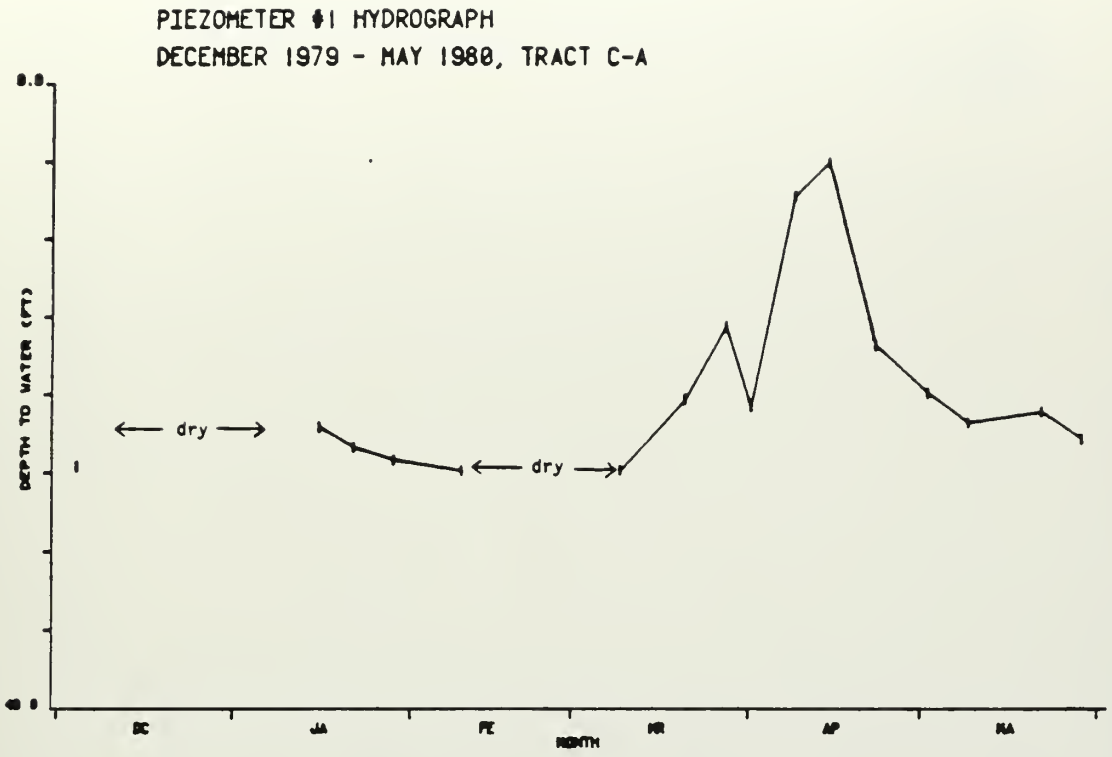

Figure 5-143. Hydrograph of Piezometer #1, December 1979 - May 1980, Tract C-a

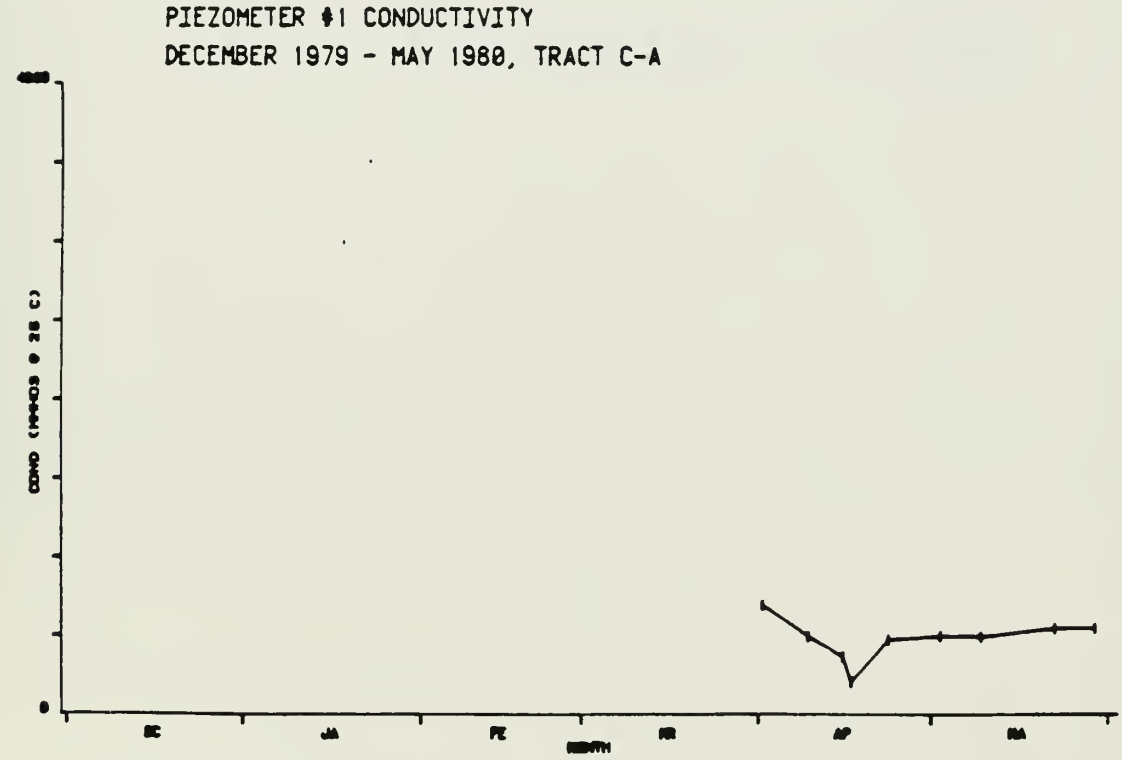

Figure 5-144. Conductivity at Piezometer #1, December 1979 - May 1980, Tract C-a

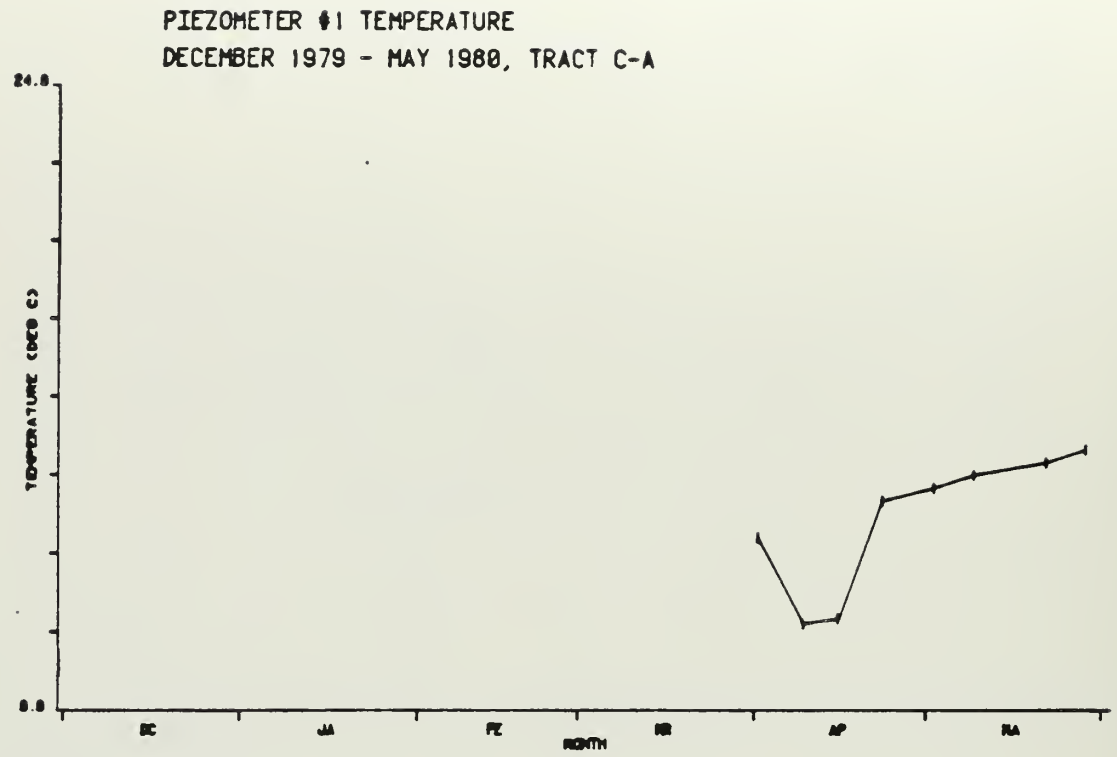

Figure 5-145. Temperature at Piezometer #1, December 1979 - May 1980, Tract C-a

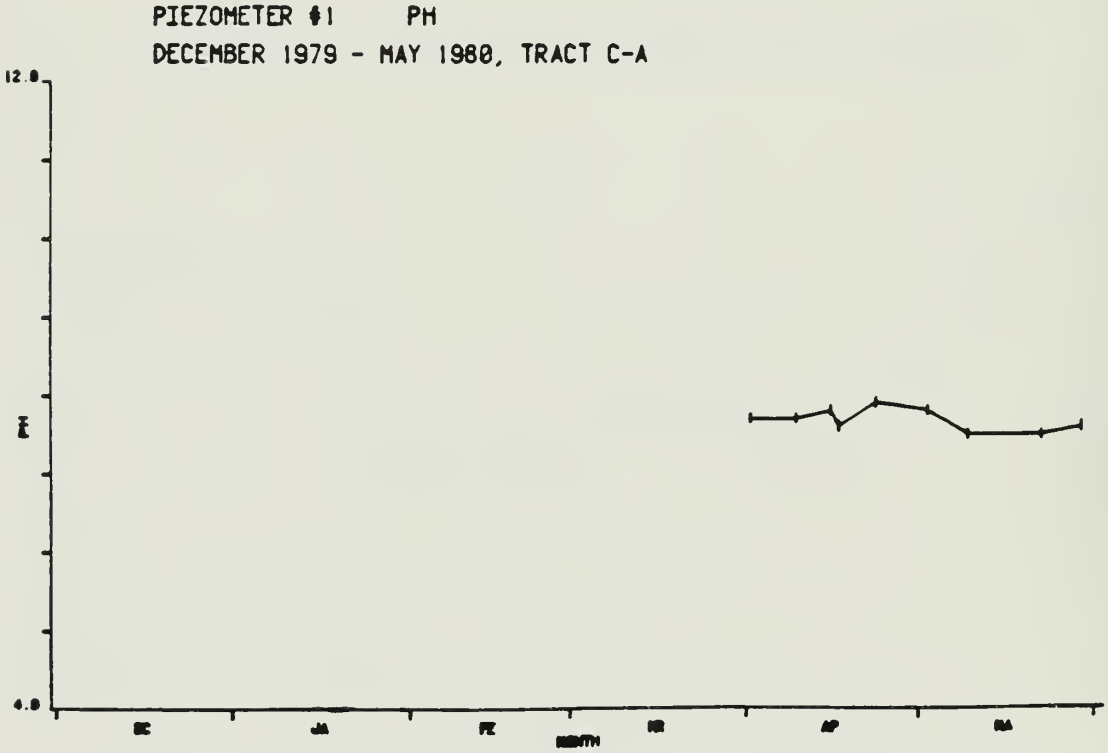

Figure 5-146. pH at Piezometer #1, December 1979 - May 1980, Tract C-a

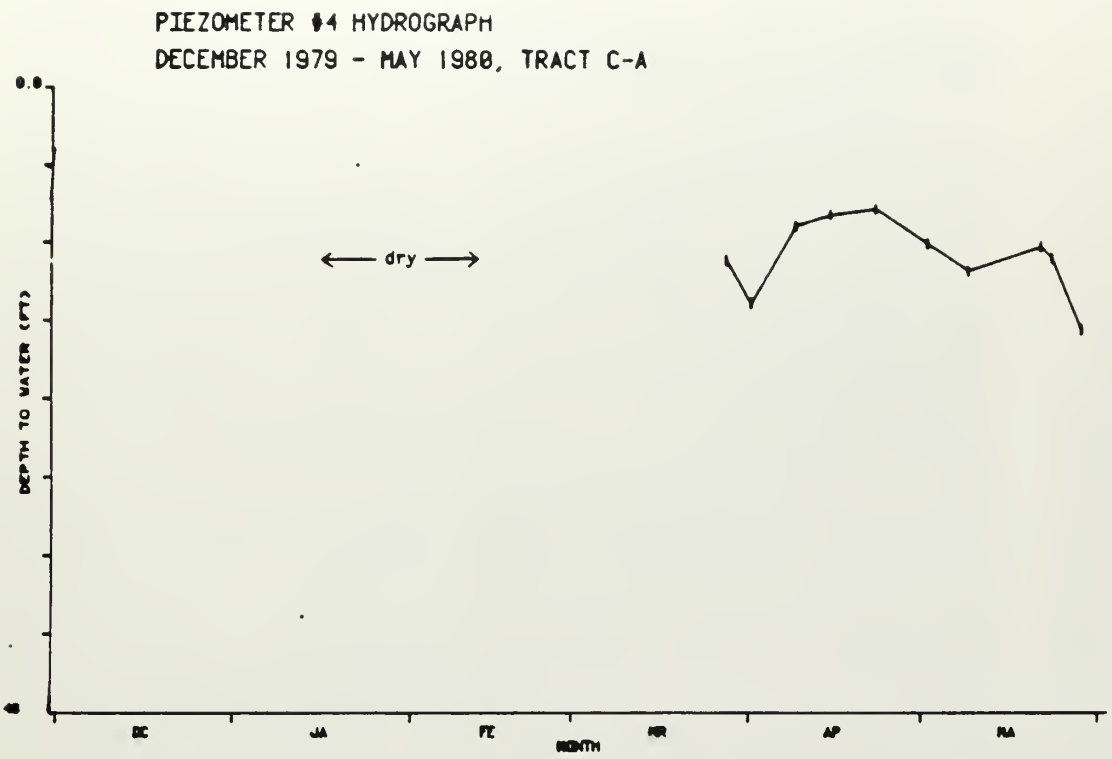

Figure 5-147. Hydrograph of Piezometer #4, December 1979 - May 1980, Tract C-a

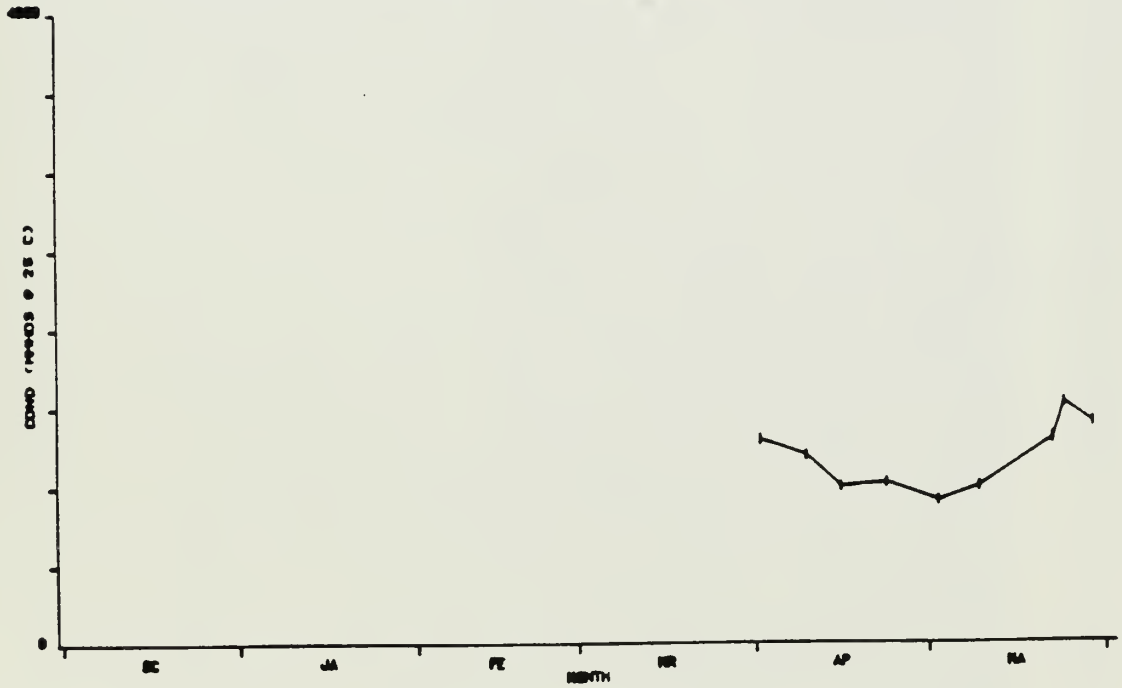

Figure 5-148. Conductivity at Piezometer #4, December 1979 - May 1980, Tract C-a

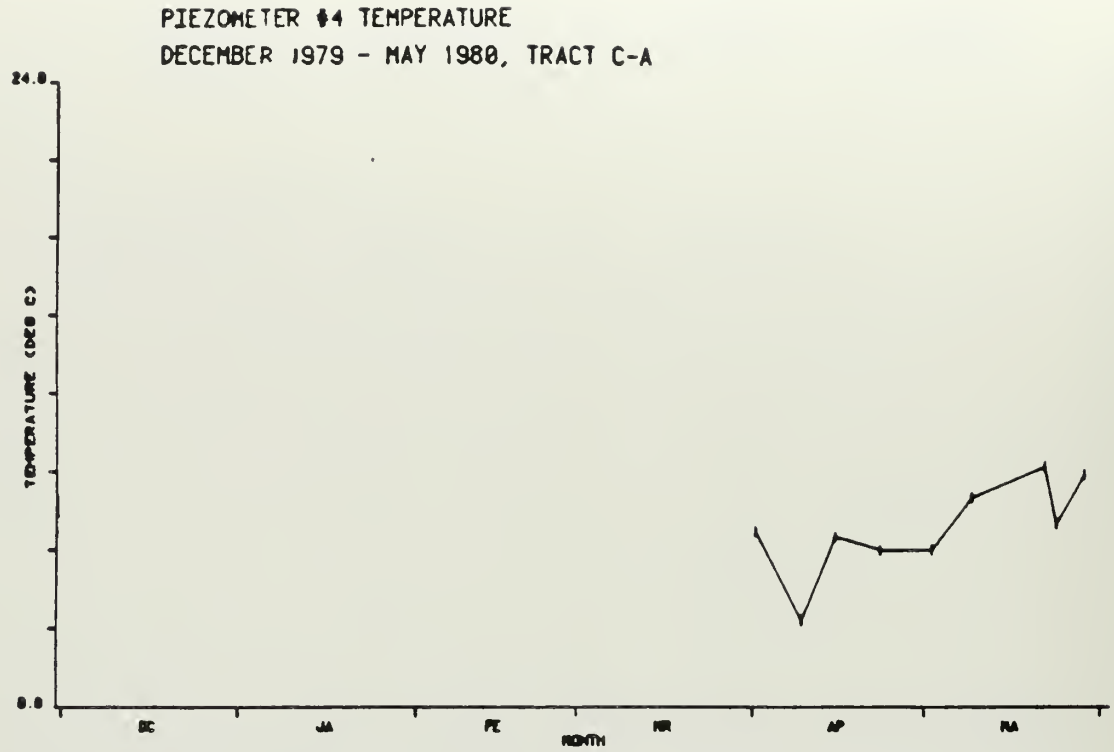

Figure 5-149. Temperature at Piezometer #4, December 1979 - May 1980, Tract C-a

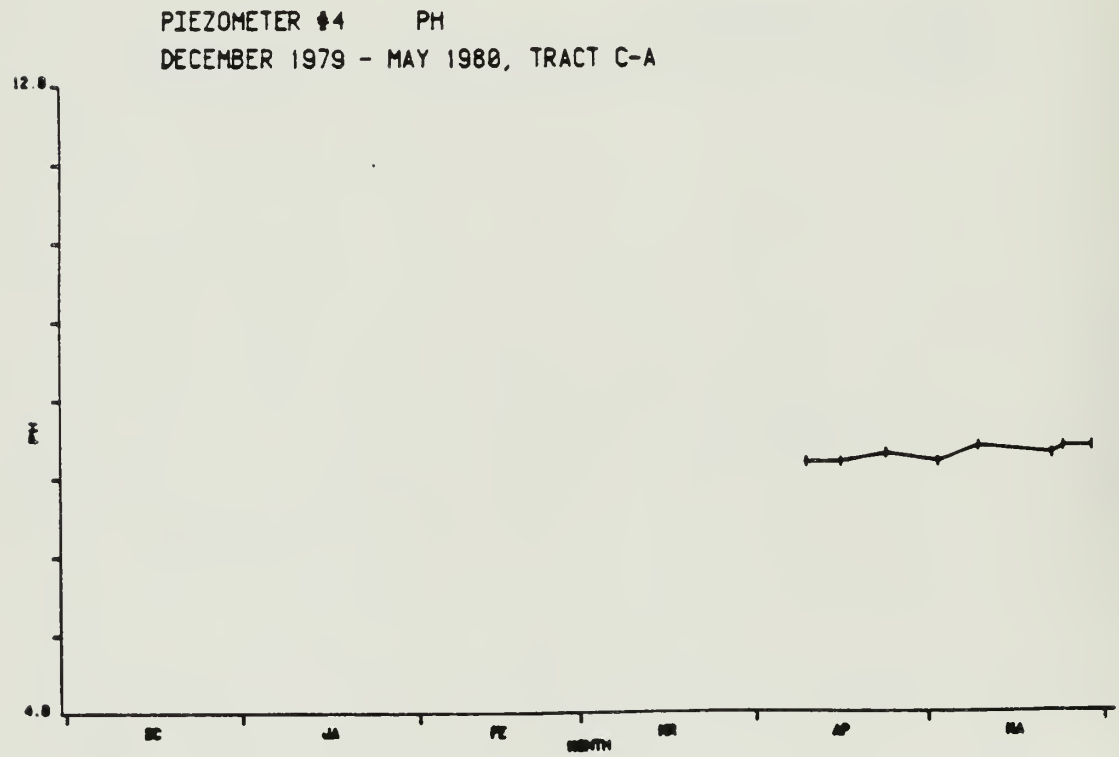

Figure 5-150. pH at Piezometer #4, December 1979 - May 1980, Tract C-a

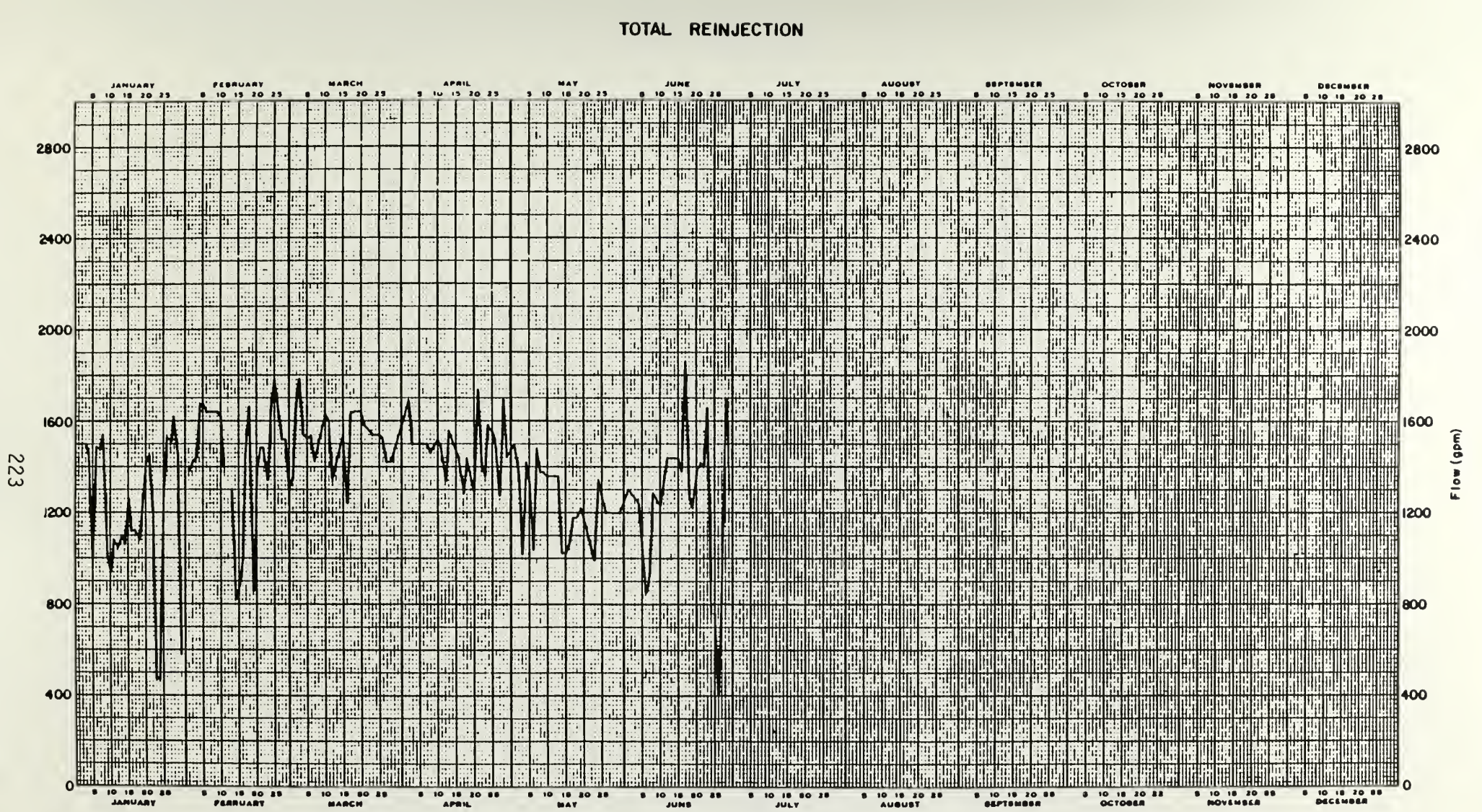

Figure 5-151. Total Water Reinjected from West Retention Pond into the Upper Aquifer, December 1979 - May 1980, Tract C-a

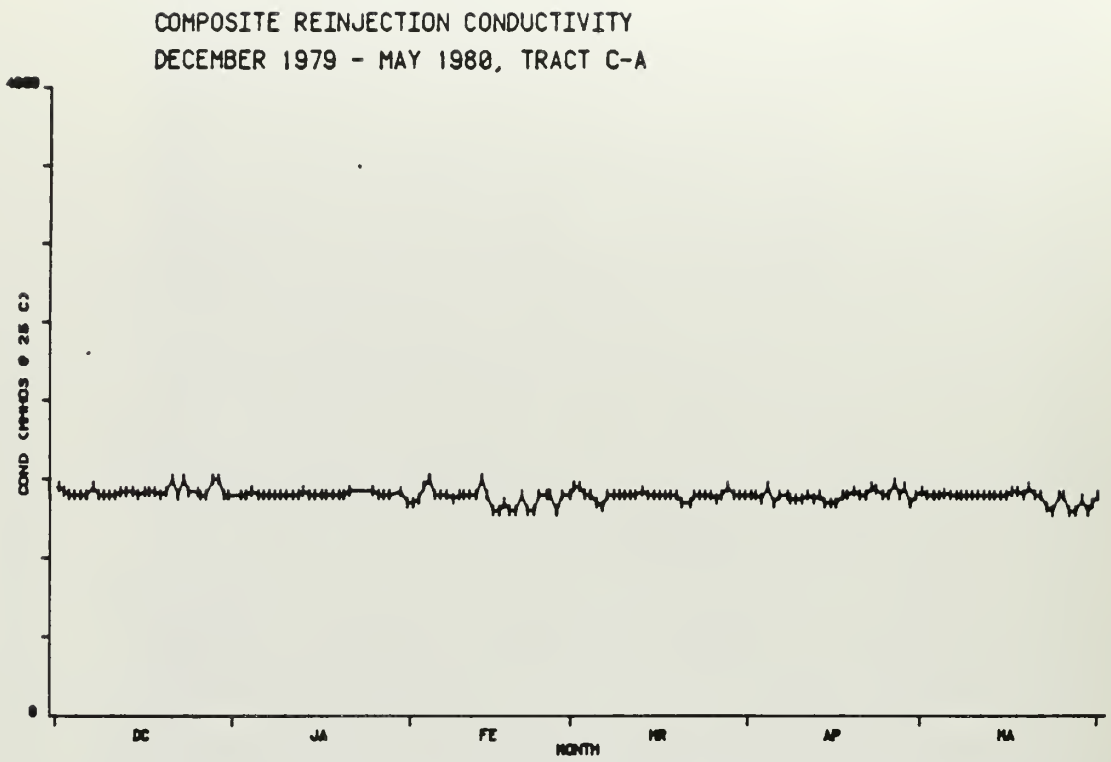

Figure 5-152. Conductivity at Composite Reinjection, December 1979 - May 1980, Tract C-a

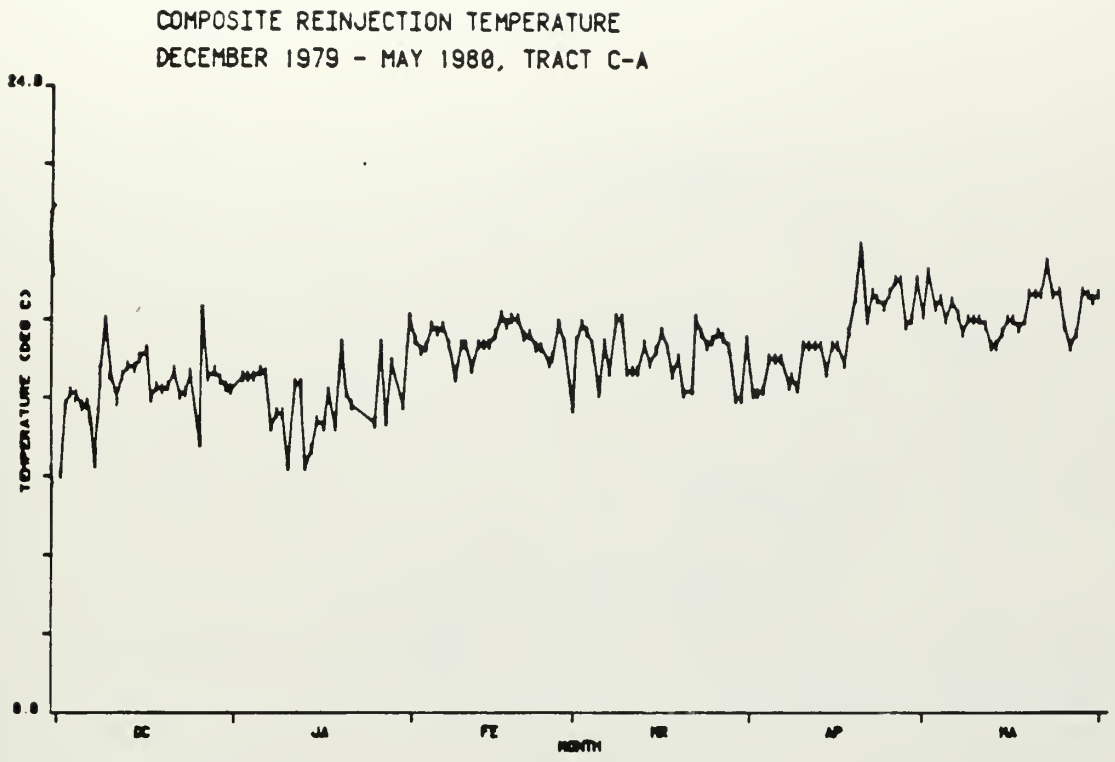

Figure 5-153. Temperature at Composite Reinjection, December 1979 - May 1980, Tract C-a

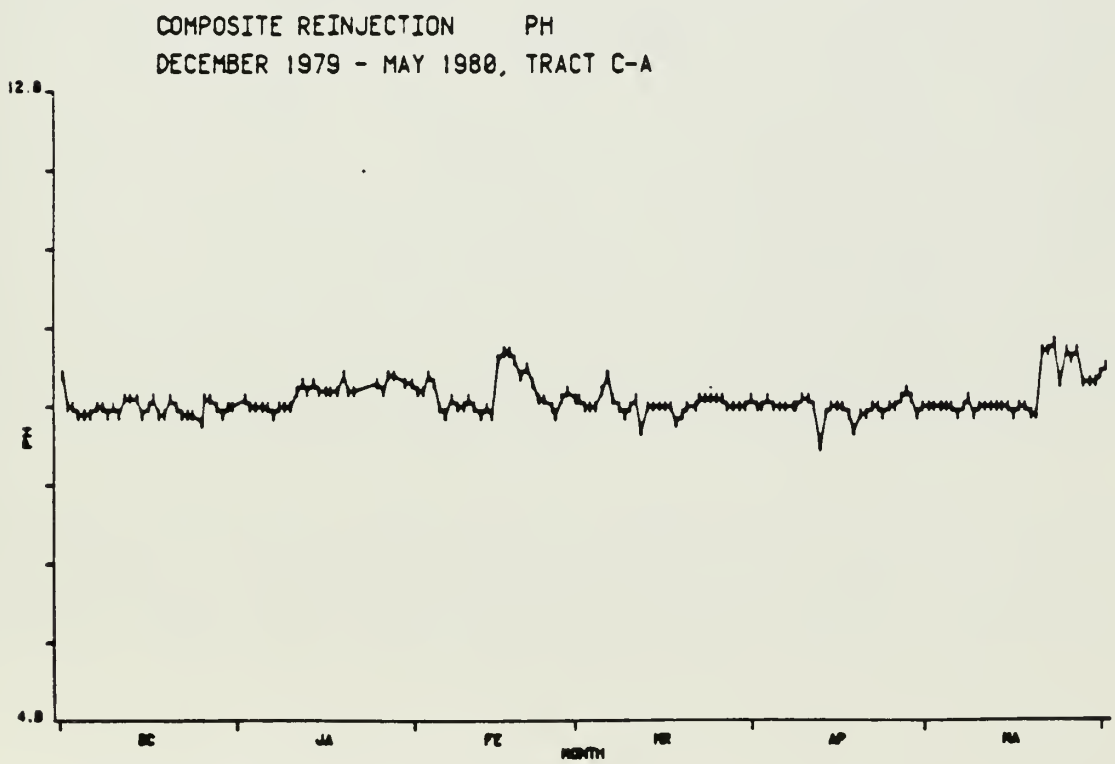

Figure 5-154. pH at Composite Reinjection, December 1979 - May 1980, Tract C-a

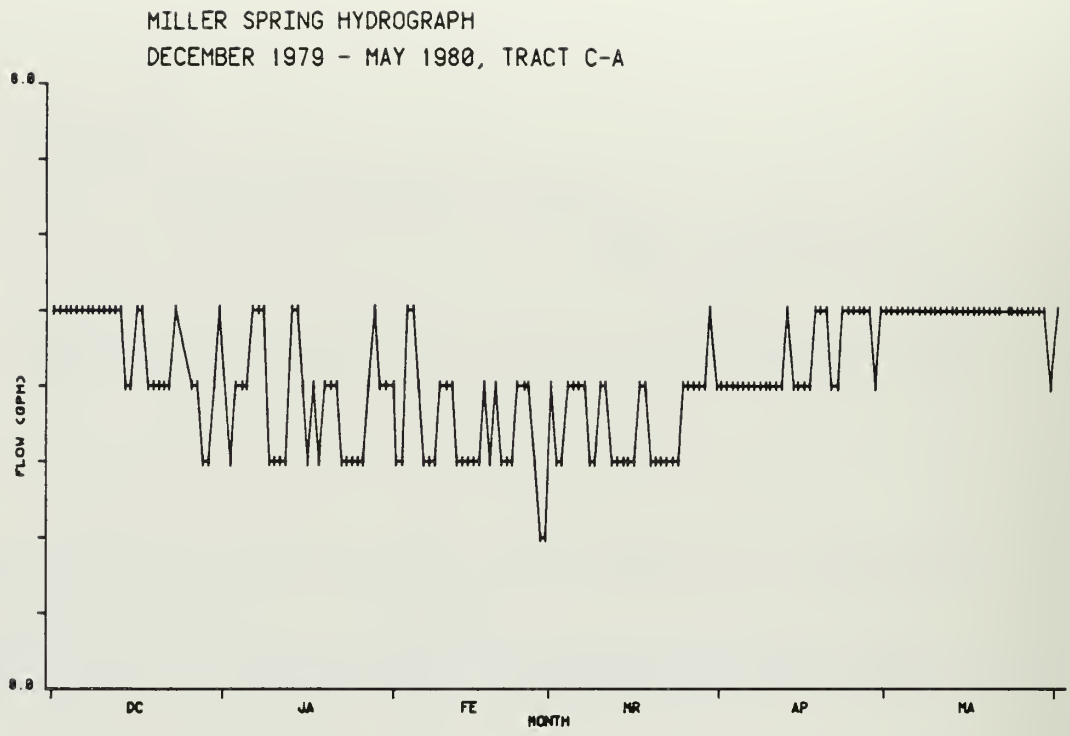

Figure 5-155. Hydrograph of Miller Spring, December 1979 - May 1980, Tract C-a

noted. Stake Springs hole is also monitored to measure response to reinjection in new wells that have not been completed yet. The hydrograph is snown in Figure 5-156. The water level has shown a slight decrease.

Physical data for Box Elder Flume are also monitored to measure the effects of reinjection. These data are plotted in Figures 5-157 through 5-160. The hydrograph shows a slightly increasing base flow from spring discharge between December and April, then a sharp response to spring runoff in April and May. Conductivities at Box Elder Flume remain fairly stable around 1500 micromhos until spring runoff when they decreased to about 1000 micromhos. Temperature profile for Box Elder Flume exhibits a normal seasonal fluctuation with numerous short-term fluctions superimposed on it. The graph of pH varied between 8.5 and 7.5.

d. Discharge monitoring - Surface discharge is shown in Figure 5-161. Minor discharge occurred in January and February. In May and early June sustained discharges of about 600 gpm were required. Physical data for the surface discharge in May is reported as the same for D-6 and D-8. A series of monitoring stations are located on Corral Gulch to monitor the effects of excess dewatering discharge on stream flow. Overflow from the West Retention Pond is measured at the flume where it enters Corral Gulch. Regular discharge is piped to the culvert near the Visitors Center at the East Tract Boundary where there is another monitoring station. Further downstream, Station MET 3 is located at U.S.G.S. Station D which is at the confluence of Box Elder and Corral Gulch. Box Elder Flume is just upstream from Station D. The SEO flume, maintained by the State Engineer's Office, located just upstream from 24-Road Crossing, was also monitored. Until November, water was flowing through a double culvert at 24-Road Crossing at which time 24-Road Crossing North was diverted to 24-Road Crossing South and 24-Road Crossing North was discontinued.

Conductivity, temperature, and pH for the West Retention Pond flume to Corral Gulch are shown in Figures 5-162 through 5-164 for the latter part of January through early March when discharges were made. The physical parameters at

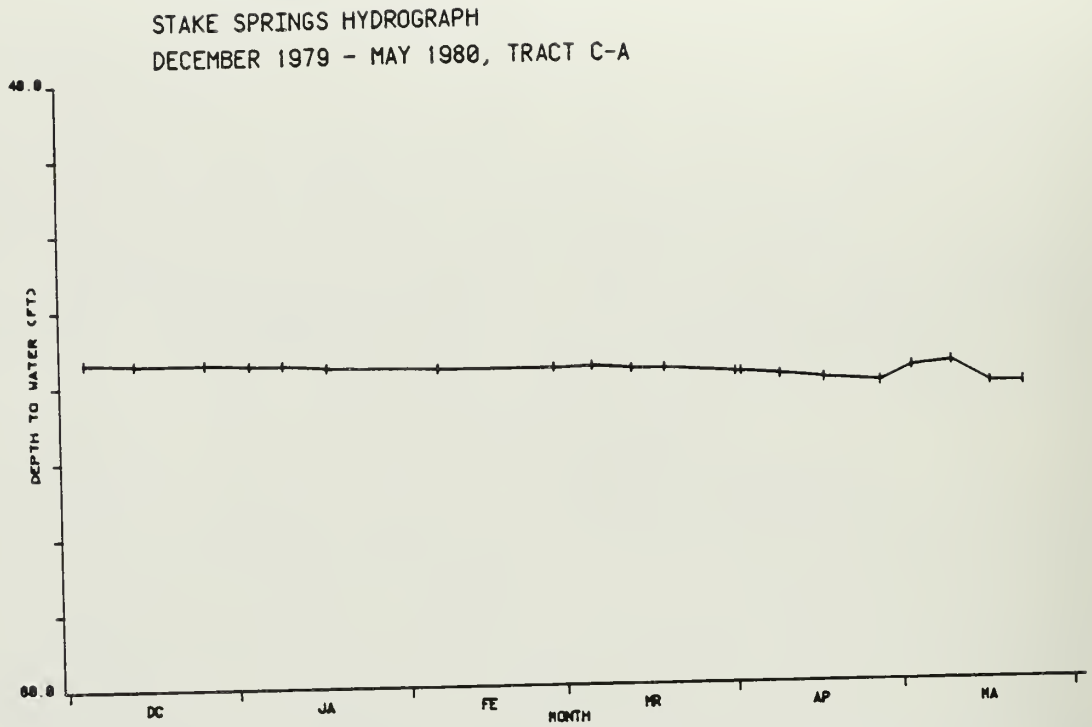

Figure 5-156. Hydrograph of Stake Springs, December 1979 - May 1980, Tract C-a

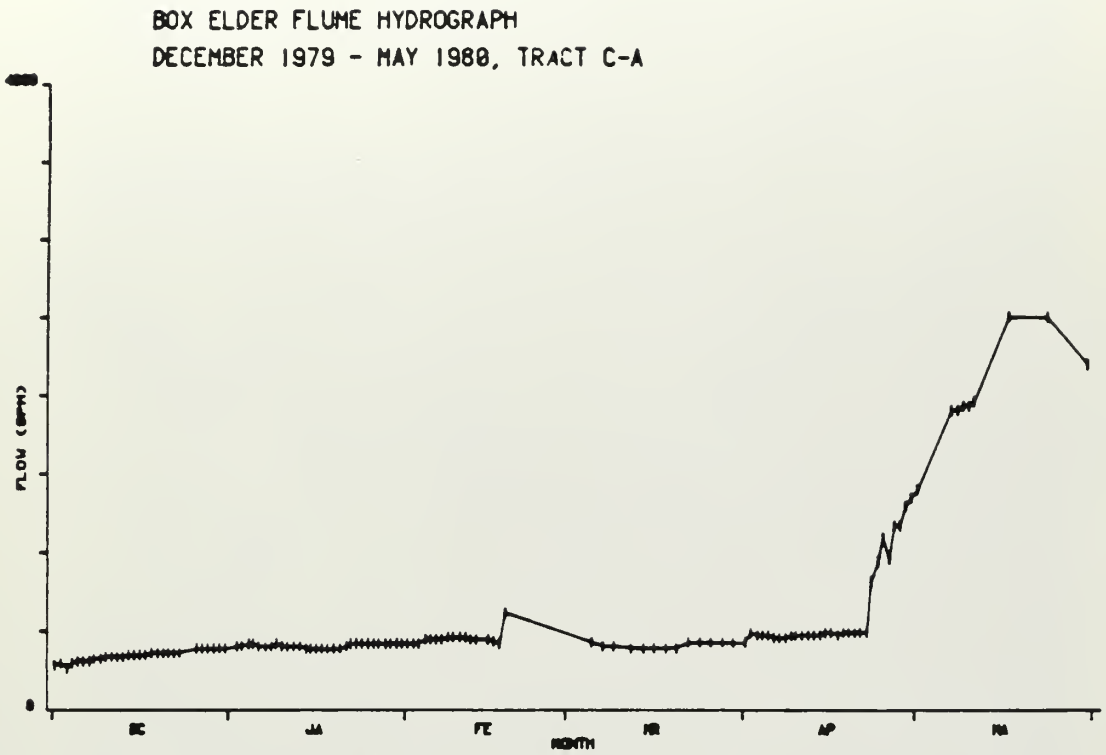

Figure 5-157. Hydrograph of Box Elder Flume, December 1979 - May 1980, Tract C-a

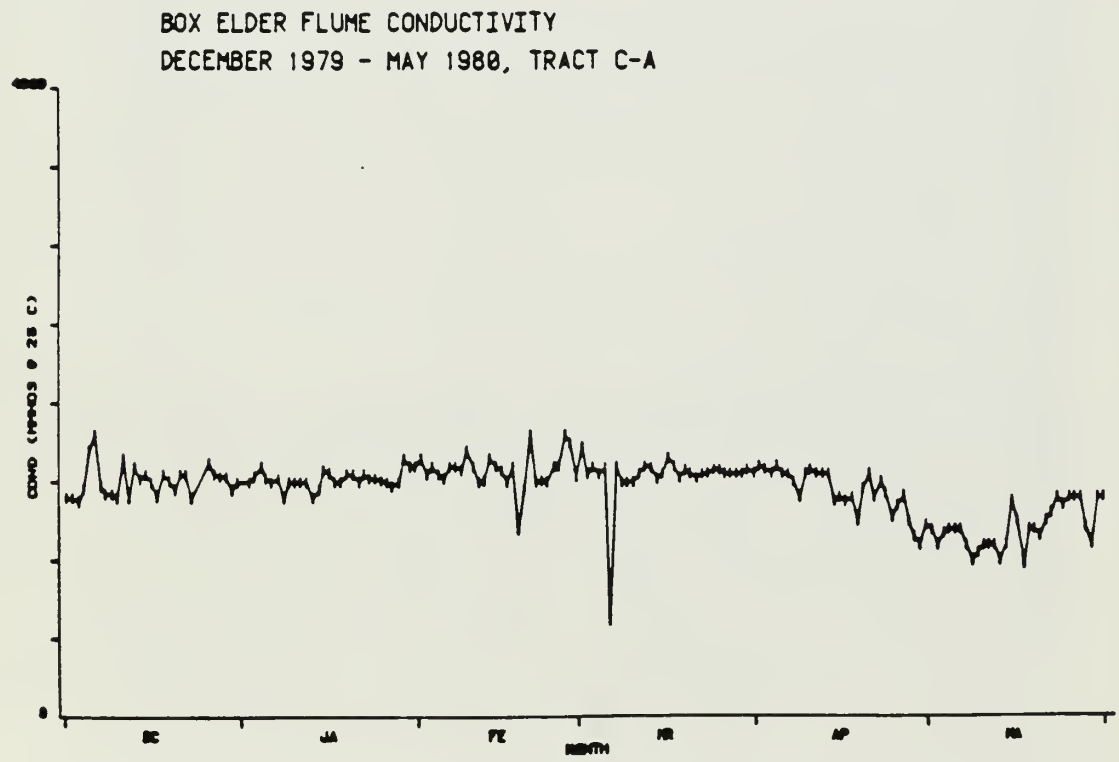

Figure 5-158. Conductivity at Box Elder Flume, December 1979 - May 1980, Tract C-a

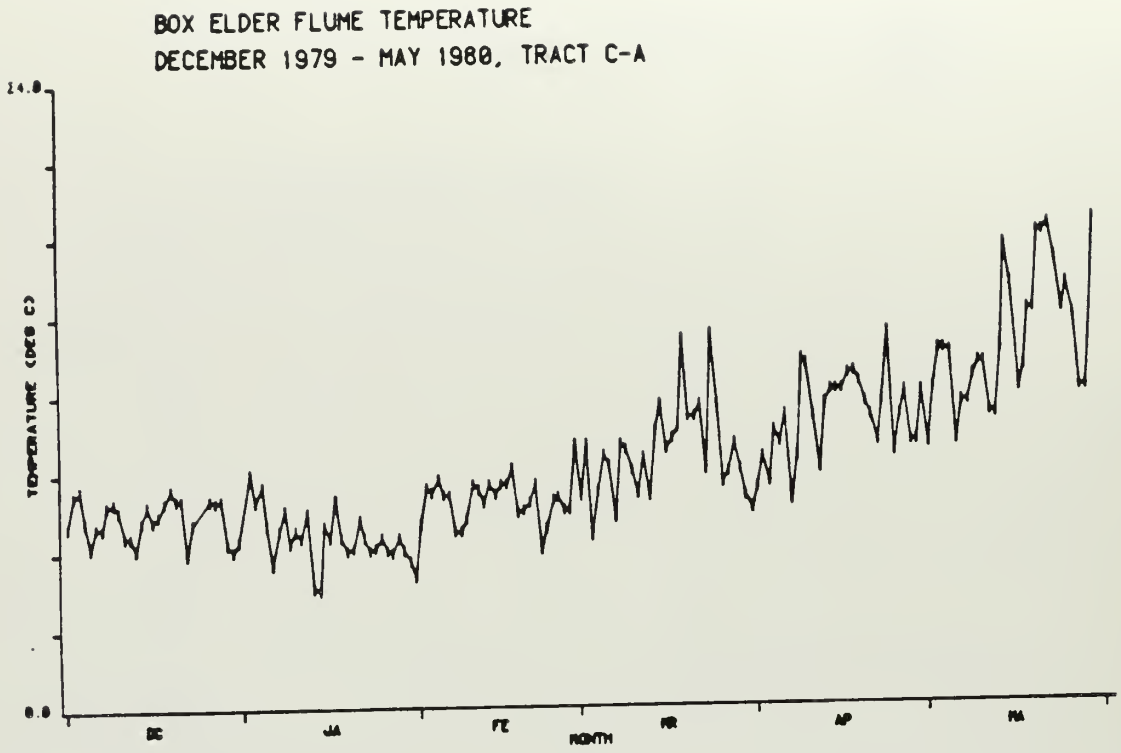

Figure 5-159. Temperature at Box Elder Flume, December 1979 - May 1980, Tract C-a

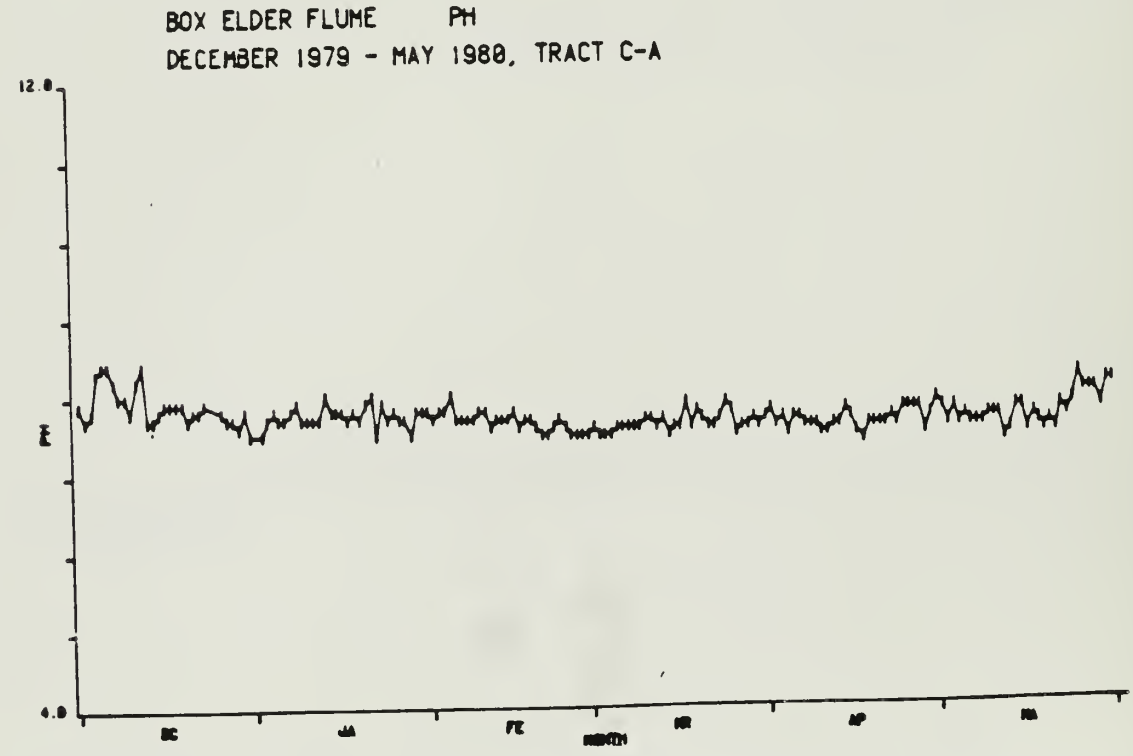

Figure 5-160. pH at Box Elder Flume, December 1979 - May 1980, Tract C-a

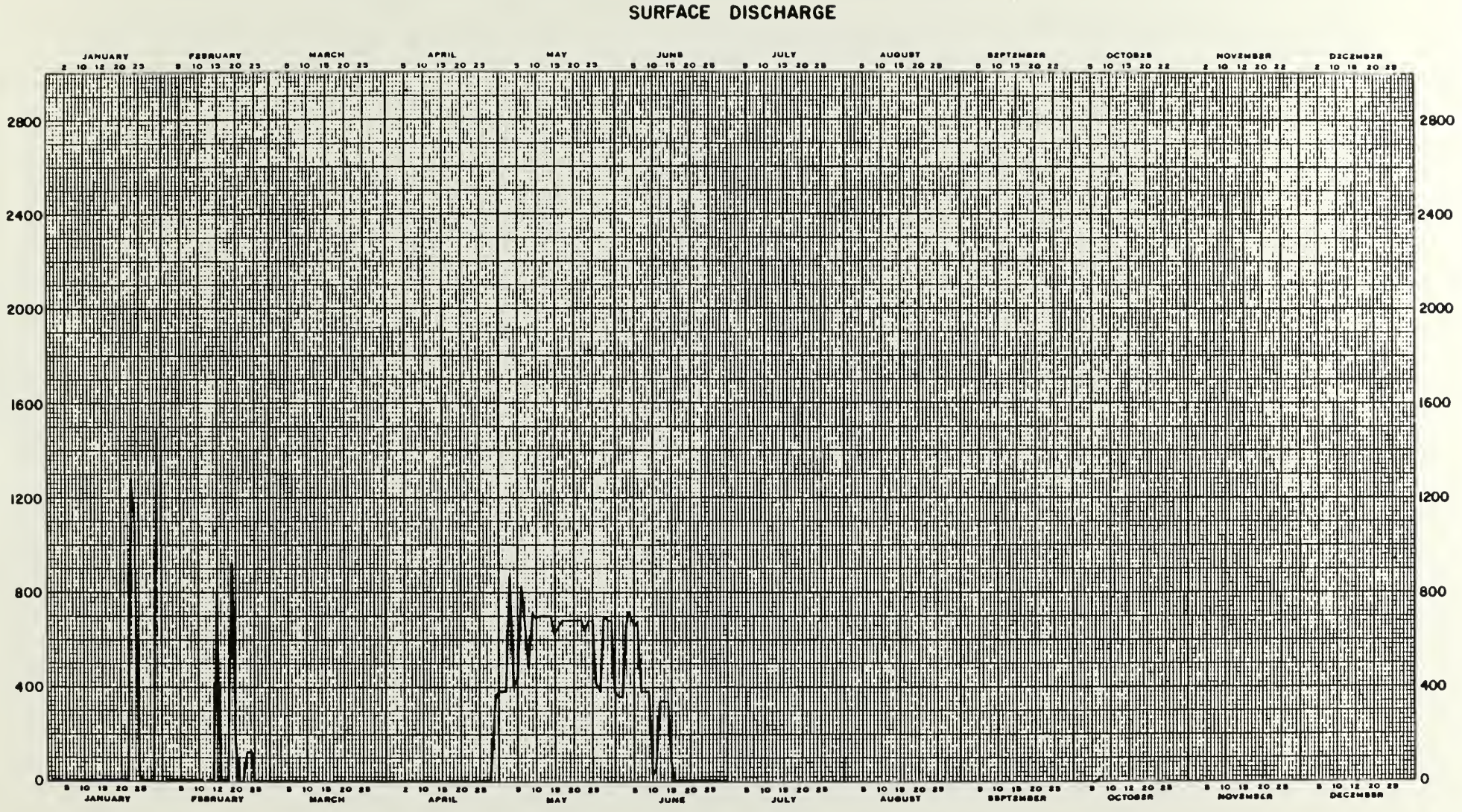

Figure 5-161. Surface Discharge, December 1979 - May 1980, Tract C-a

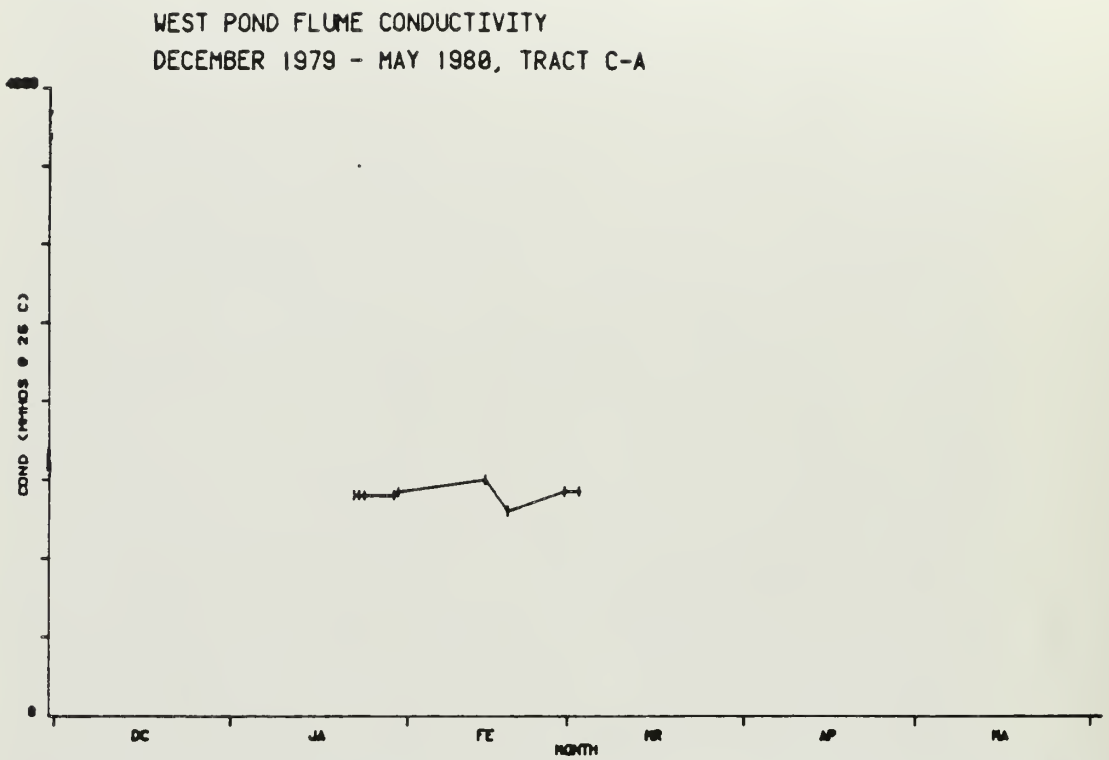

Figure 5-162. Conductivity at West Retention PondFlume, December 1979 - May 1980, Tract C-a

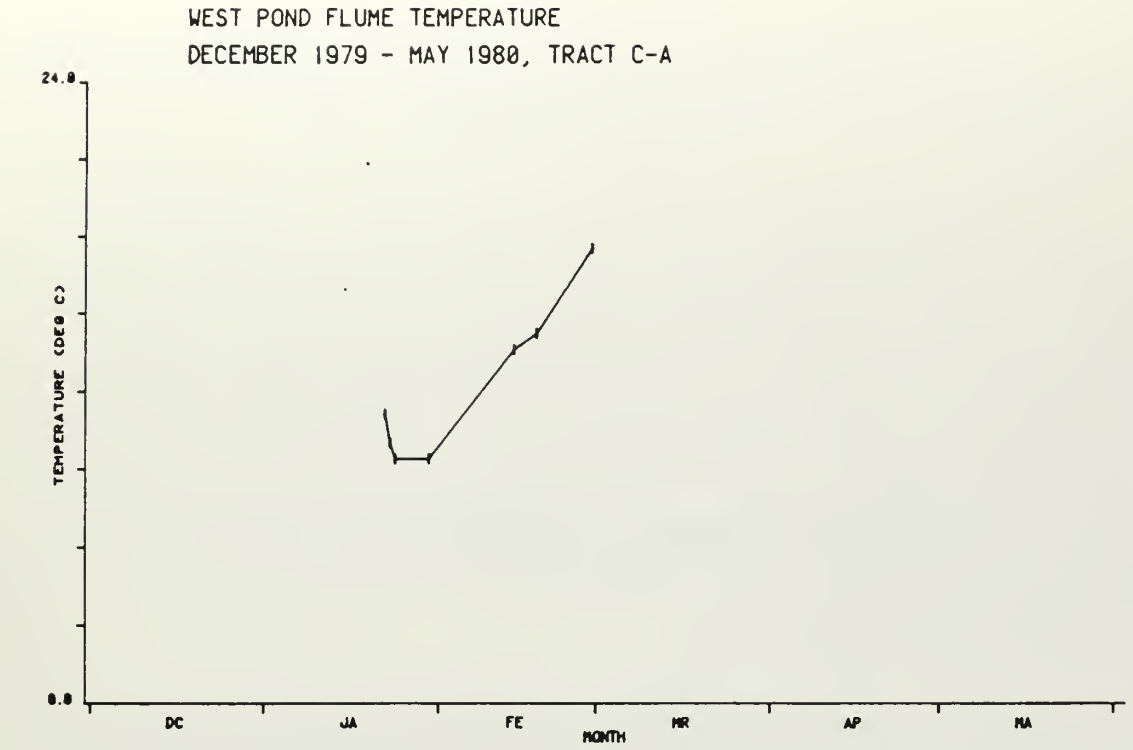

Figure 5-163. Temperature at West Retention Pond Flume, December 1979 - May 1980, Tract C-a

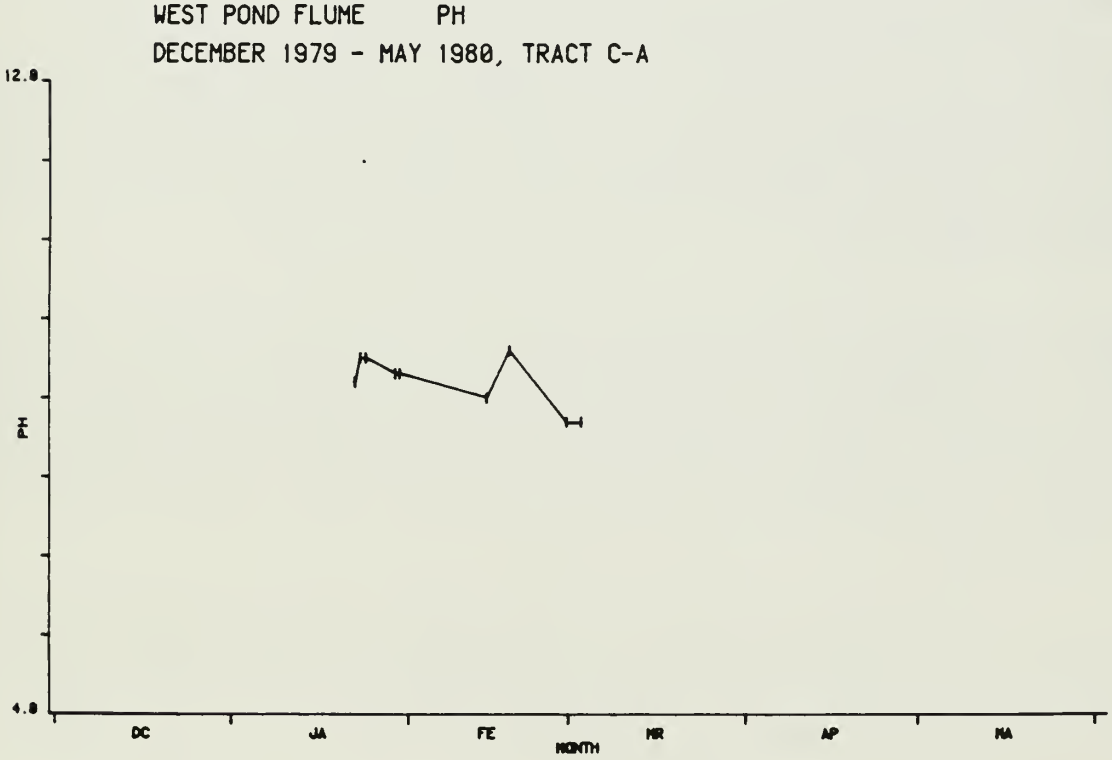

Figure 5-164. pH at West Retention Pond Flume, December 1979 - May 1980, Tract C-a

the flume generally reflected West Retention Pond conditions, but with more fluctuations.

MET No. 3 is the U.S.G.S. monitoring Station D and is called MET 3 to distinguish results from U.S.G.S. data. Daily flows and water quality data for this station are reported in Appendix 5-1.1 and 5-1.2. Graphs of conductivity, temperature, and pH, measured by tract personnel, are shown for this station in Figures 5-165 through 5-167. Conductivity was relatively stable between 1500 and 1600 micromhos until the spring run-off reduced conductivity about 400 micromhos. Temperature and pH plots exhibited short-term fluctuations, with temperature increasing in a seasonal trend, and pH varying between 8.5 and 7.5.

The physical data for the SEO Flume are plotted in Figures 5-168 through 5-171. The base flow decreased gradually from December through April. The peaks in February and May are a result of surface runoff and discharge added to the baseflow. Conductivity was fairly stable until April, with two significant decreases in February and March, which occurrences were on the same days for which large flows were recorded by the U.S.G.S. The conductivity decreased during April and May, as a result of dillution from runoff. The temperature exhibits numerous short-term fluctuations around a seasonal trend with highest temperatures in April and May. The pH varied between 8.5 and 7.5

Plots of physical data for 24-Road Culvert are shown on Figures 5-172 through 5-175. The water level rose about three feet in February. Conductivities were relatively stable at 2100 micromhos until May when they decreased somewhat. The temperature exhibited a seasonal trend. The pH varied between 8.5 and 7.5.

The plot of the location of the "leading edge" is shown in Figure 5-176. The leading edge is defined as the distance downstream from 24-Road Crossing where the stream disappears. Under normal conditions, the lower portion of Corral Gulch down to the confluence of Yellow Creek is dry during much of the year. The leading edge was monitored to measure the impact of discharges on

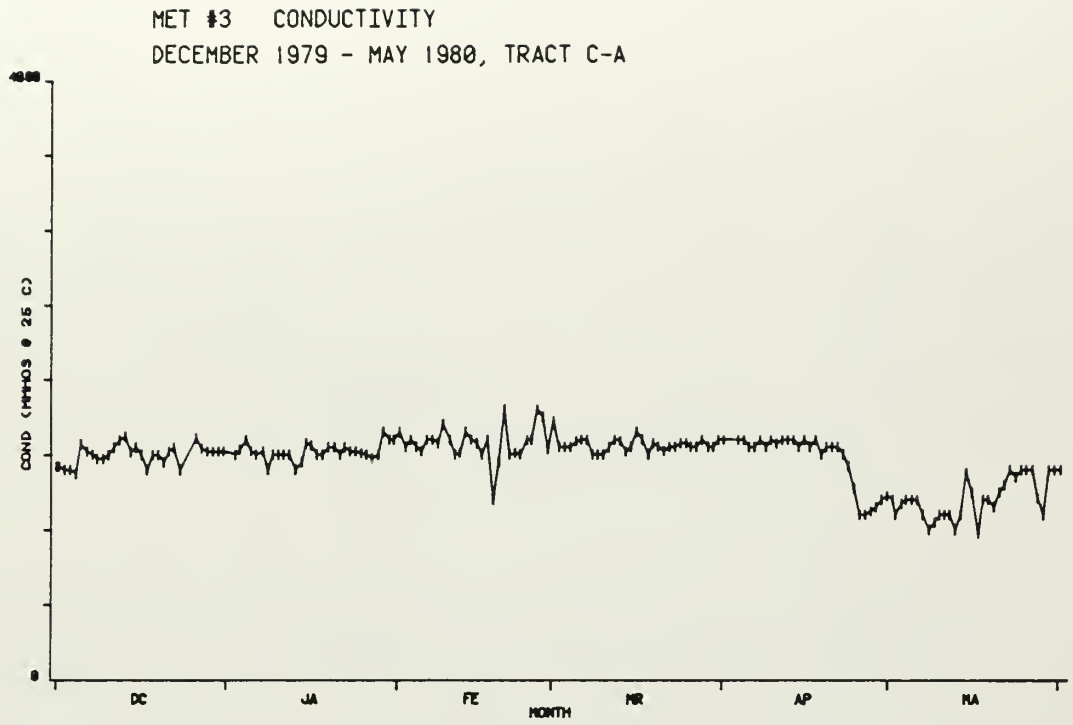

Figure 5-165. Conductivity at MET #3, December 1979 - May 1980, Tract C-a

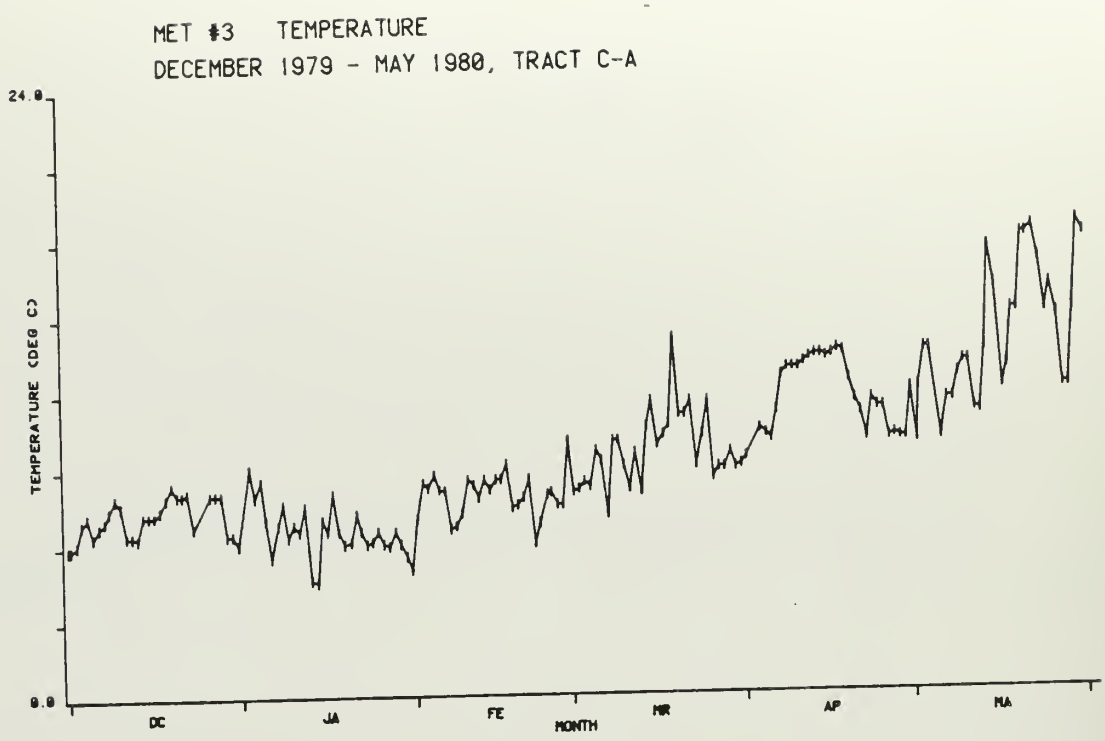

Figure 5-166. Temperature at MET #3, December 1979 - May 1980, Tract C-a

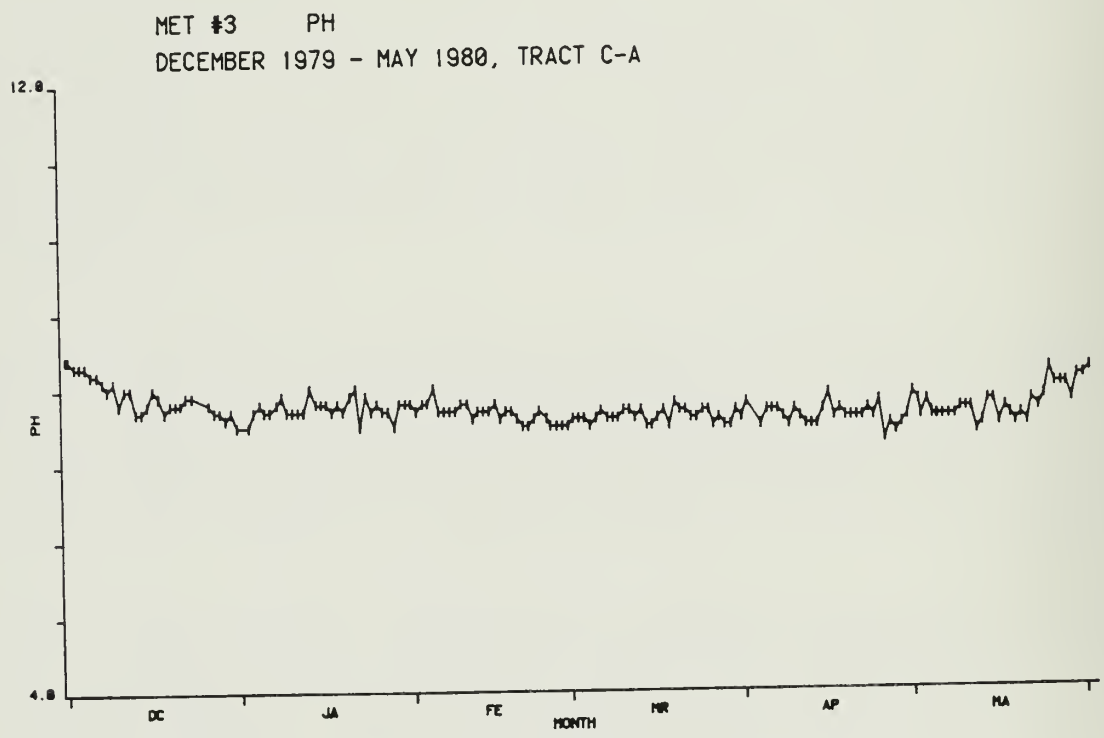

Figure 5-167. pH at MET #3, December 1979 - May 1980, Tract C-a

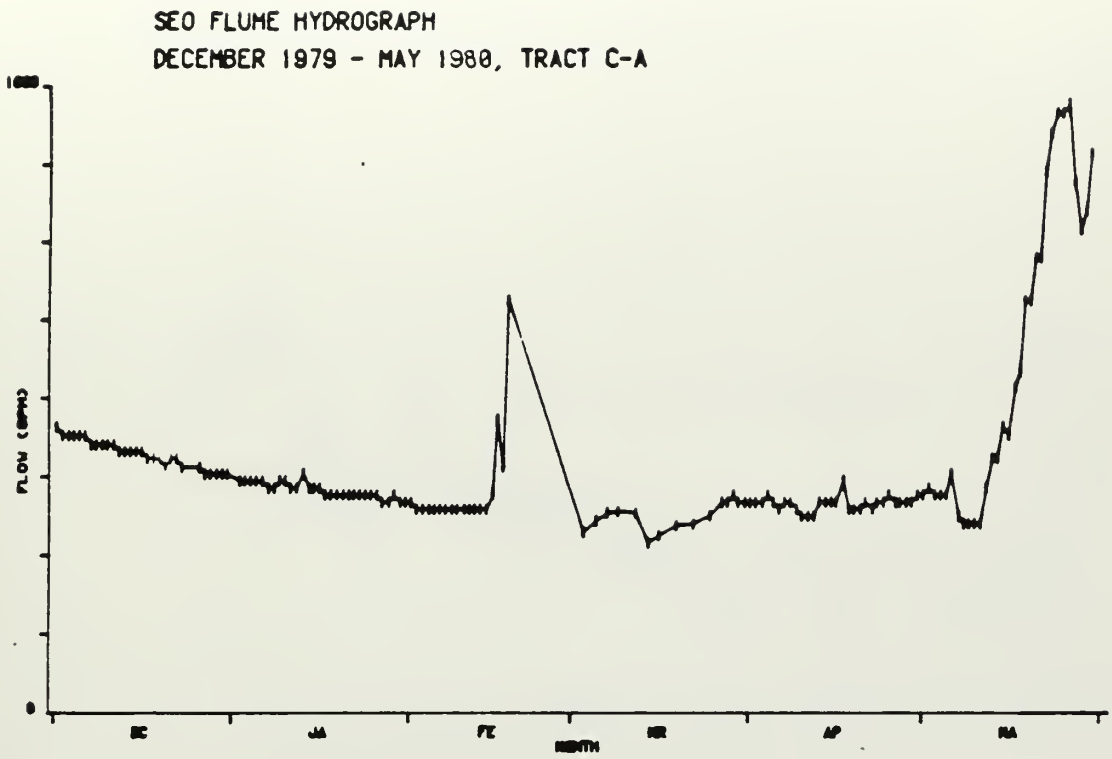

Figure 5-168. Hydrograph of SEO Flume, December 1979 - May 1980, Tract C-a

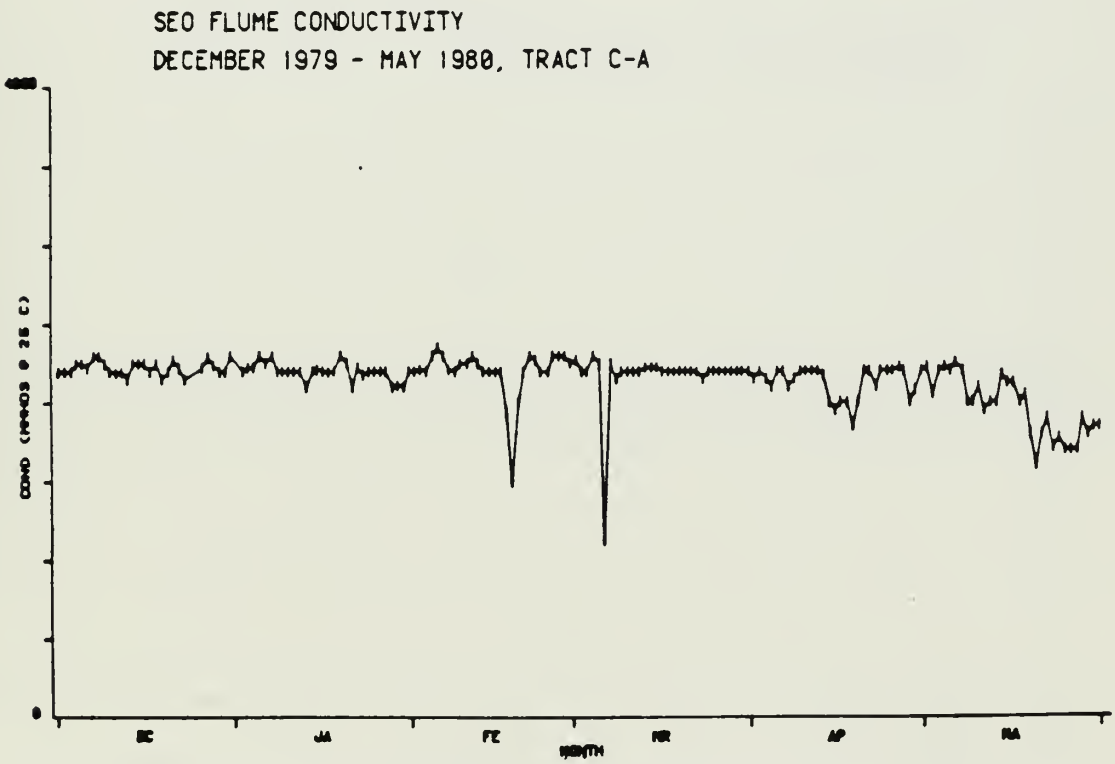

Figure 5-169. Conductivity at SEO Flume, December 1979 - May 1980, Tract C-a

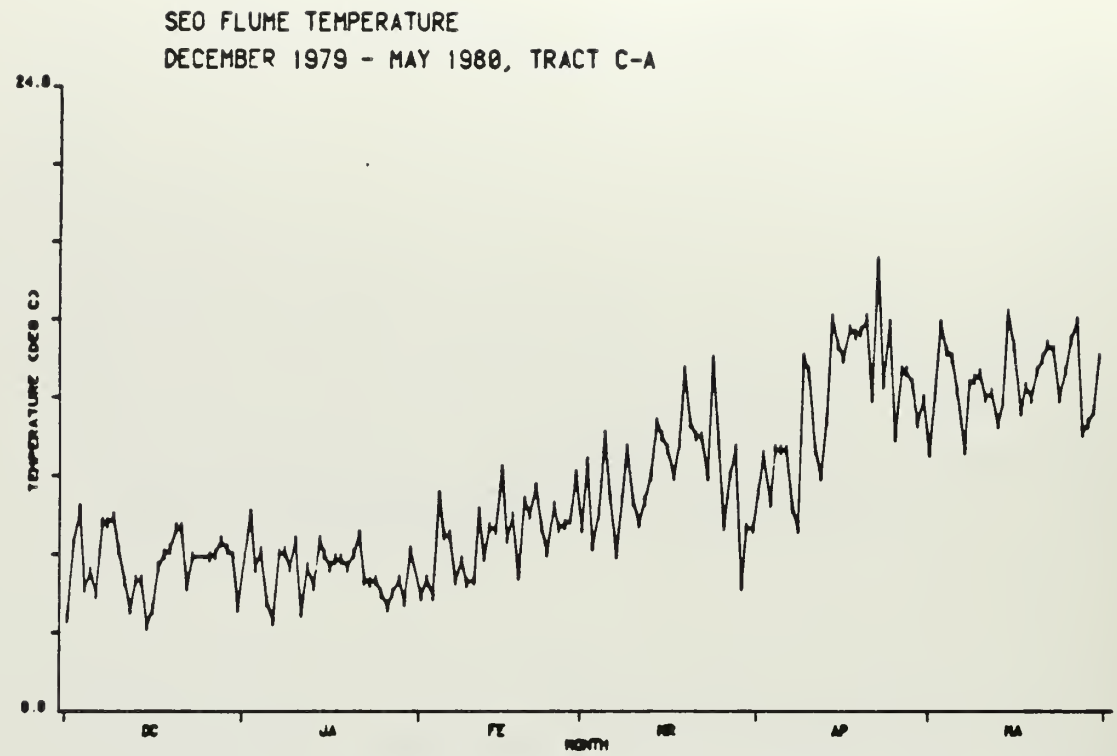

Figure 5-170. Temperature at SEO Flume, December 1979 - May 1980, Tract C-a

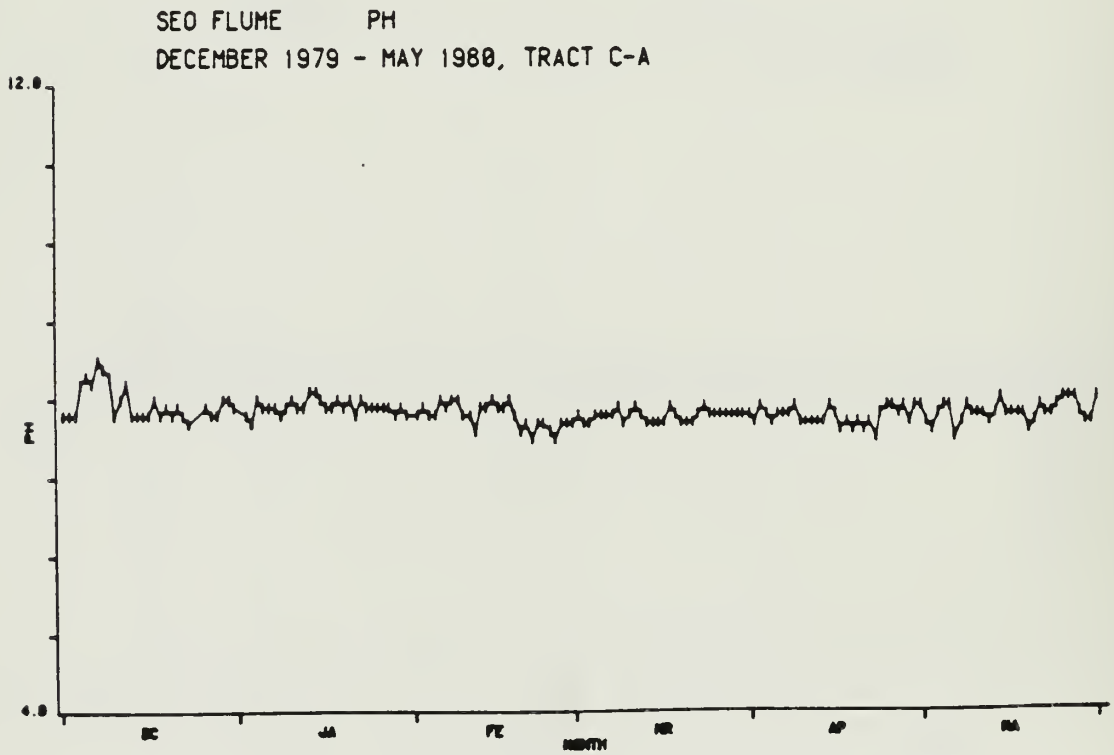

Figure 5-171. pH at SEO Flume, December 1979 - May 1980, Tract C-a

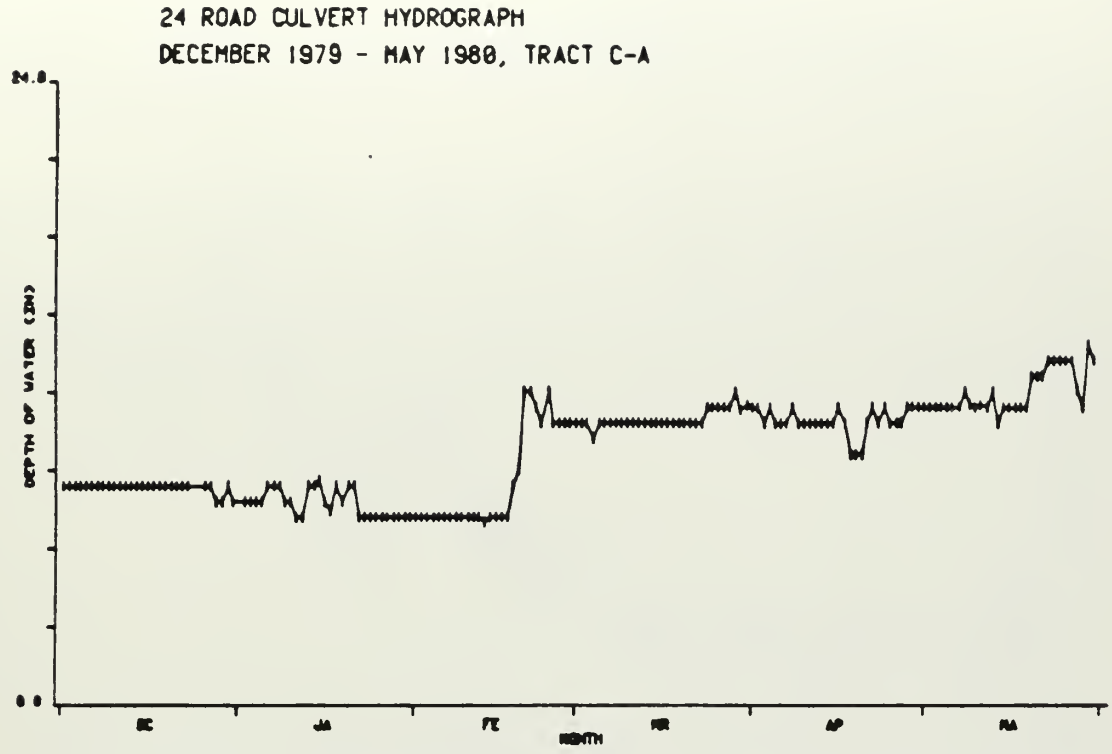

Figure 5-172. Hydrograph of 24 Road Culvert, December 1979 - May 1980, Tract C-a

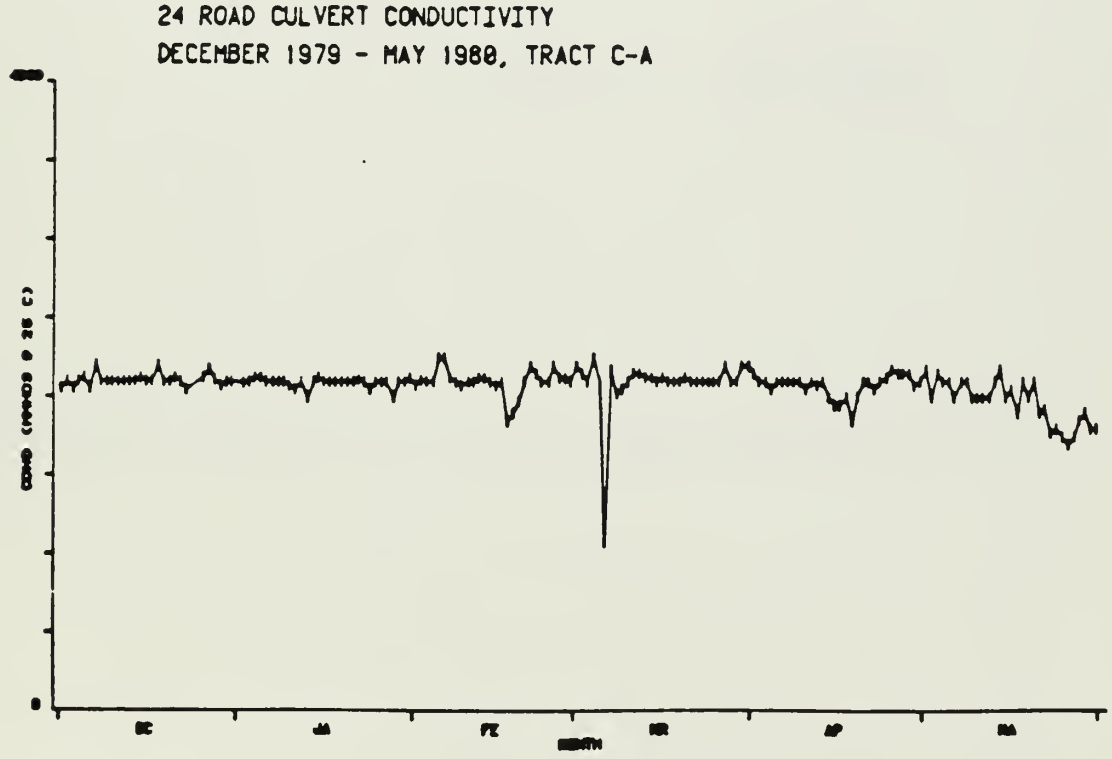

Figure 5-173. Conductivity at 24 Road Culvert, December 1979 - May 1980, Tract C-a

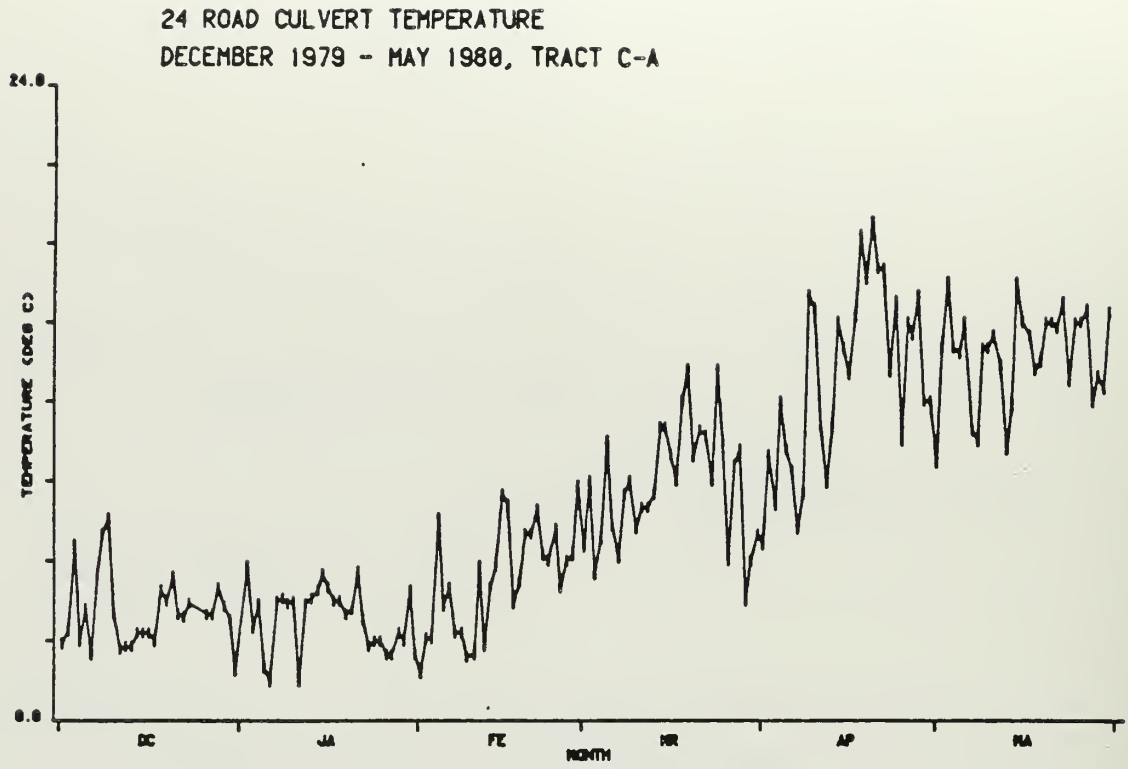

Figure 5-174. Temperature at 24 Road Culvert, December 1979 - May 1980, Tract C-a

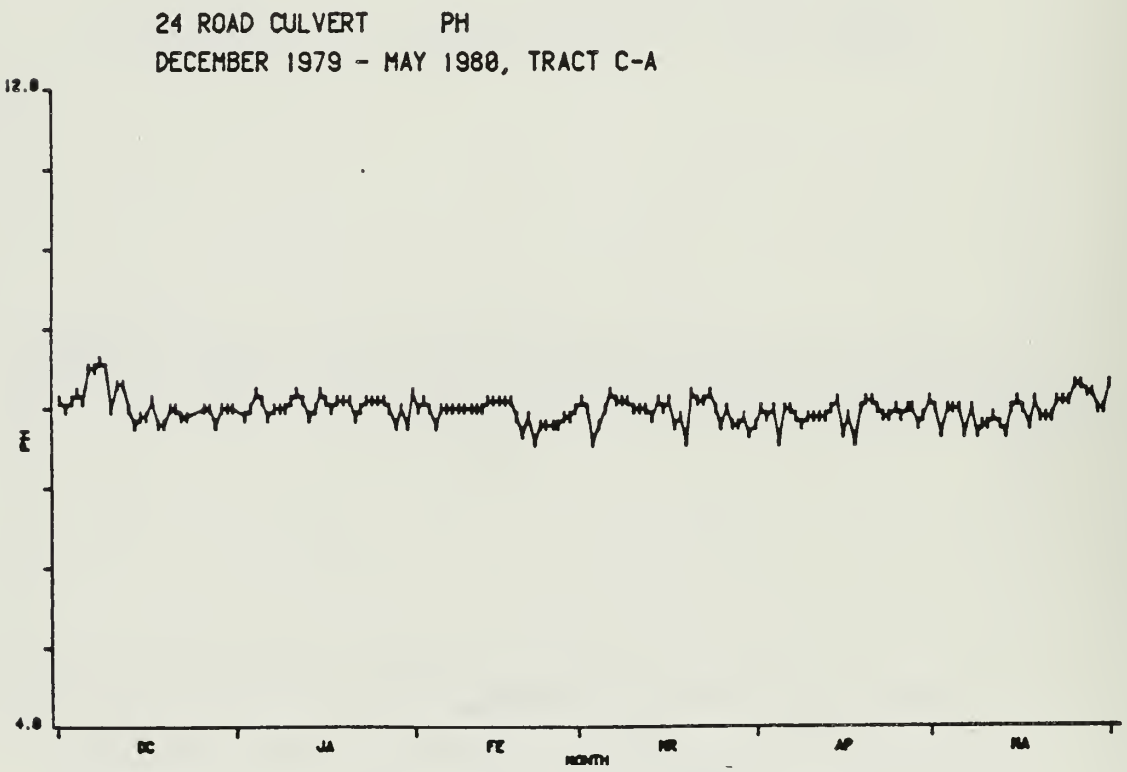

Figure 5-175. pH at 24 Road Culvert, December 1979 - May 1980, Tract C-a

the hydrology of Corral Gulch. For most of the reporting period, the leading edge was located about 1.5 miles downstream of the 24-Road Crossing. The discharge in February advanced the leading edge about .5 miles downstream, but the runoff in May did not.

Consumptive use is shown in Figure 5-177. Water needs have fluctuated from 100 gpm to 600 gpm averaging about 250 gpm. Total water disposal is shown in Figure 5-178. It follows water production fairly well, but fluctuates much more. At times, it appears there may be some recycling of water (100 to 200 gpm) consumed for plant operations.

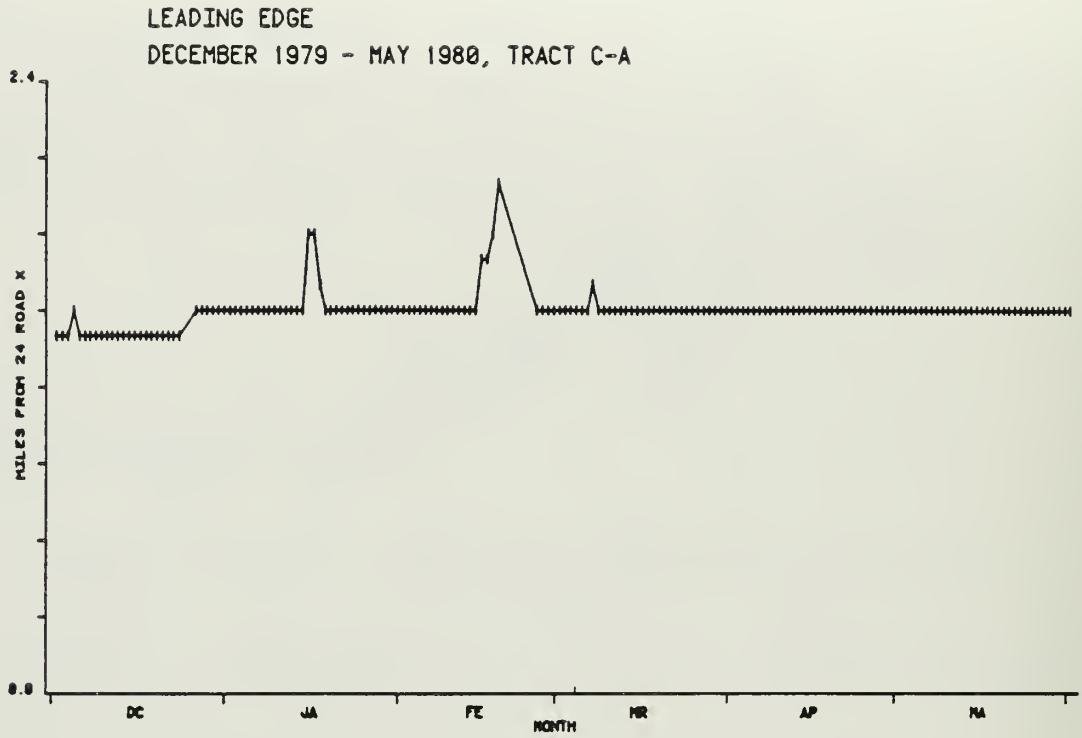

Figure 5-176. Location of "Leading Edge", December 1979 - May 1980, Tract C-a

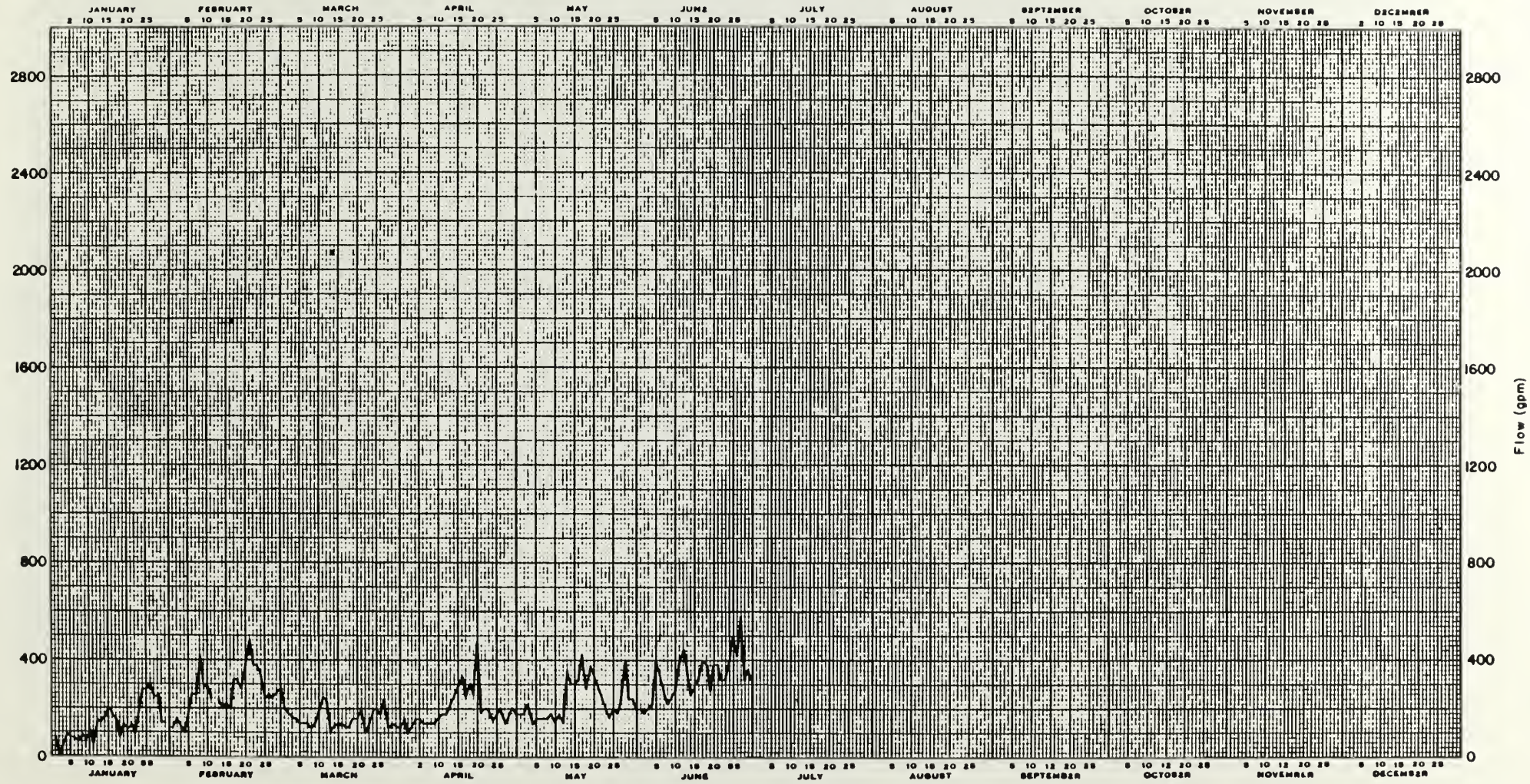

Figure 5-177. Consumptive Use, December 1979 - May 1980, Tract C-a

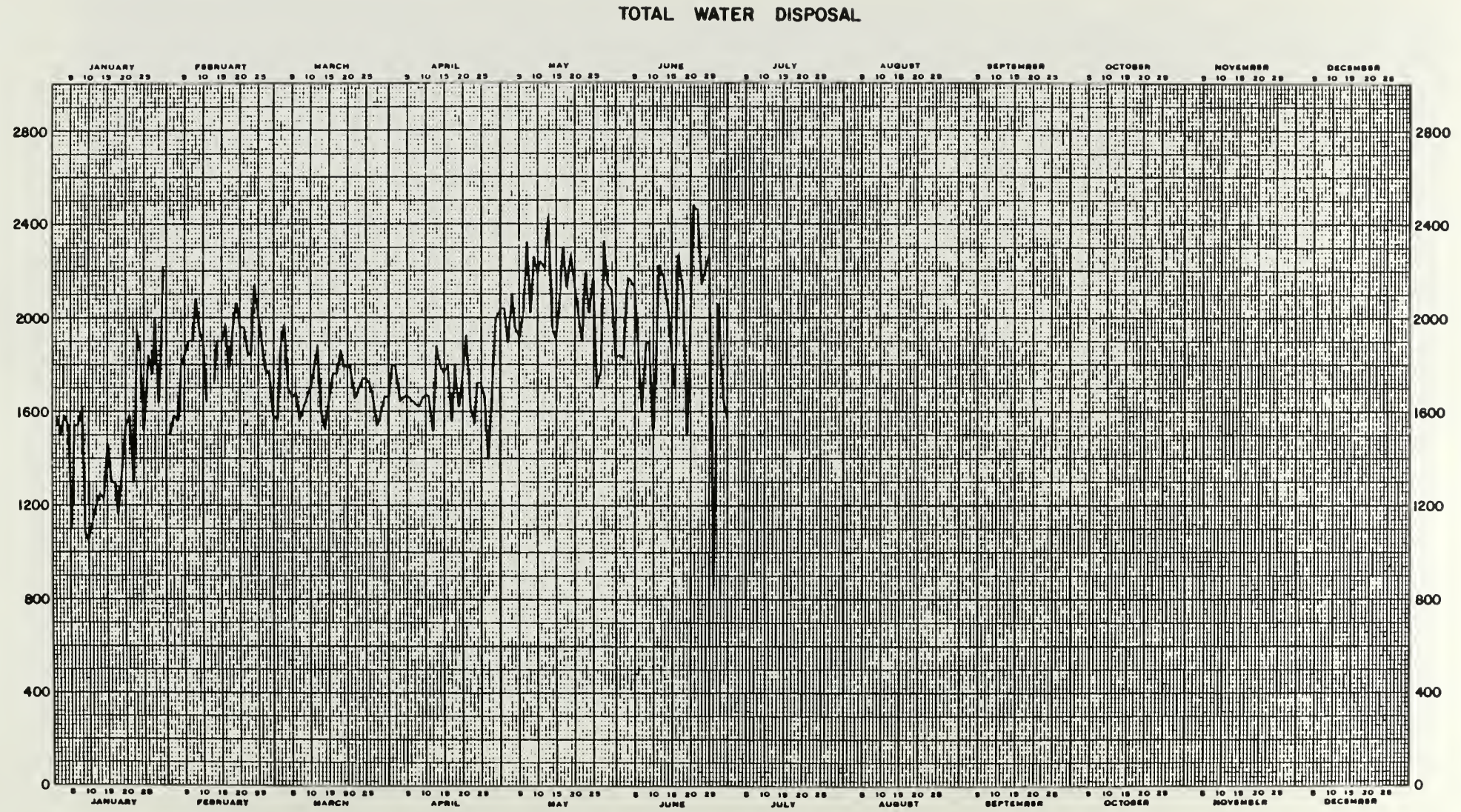

Figure 5-178. Total Water Disposal, December 1979 - May 1980, Tract C-a

5.4 SUMMARY

The hydrology program provides data necessary to satisfy lease stipulations and conditions of approval from the AOSO; assess impacts of dewatering and reinjection (development activities); provide input to engineering design of the mine and water handling system; supply information necessary for environmental disciplines to determine if mitigative measures are necessary; and collect data for compliance with permit stipulations. Data collected between December 1979 and May 1980 were compared with data collected during baseline studies initiated in July 1974. Stream gaging and erosion stations, springs and seeps, alluvial and deep aquifer holes, surface water impoundment, discharges, and reinjection and dewatering wells were monitored.

The results of the hydrology program are summarized below:

- Surface Water - Of the six gaging stations monitored, one, Rinky Dink Gulch failed to show any flow during the reporting period. During most of the reporting period, there were no surface discharges.

- Springs and Seeps - Physical data for all springs and seeps fell within baseline ranges with the exception of Station #14 on Corral Gulch.

- Alluvial Groundwater - Many of the alluvial wells remained dry throughout the reporting period, a condition similar to that experienced during baseline monitoring. Physical data for the alluvial wells generally fluctuated within baseline ranges. A short term conductivity peak was noticed in G-S S11 during December.

- Upper and Lower Aquifer Water - Natural recharge occurred in the west and northwest portions of the tract. Reinjection was reinitiated in the northwest corner of the tract during the reporting period.

- Development Activities - Two new dewatering wells were completed which increased the total water production about 400 gpm.

SECTION 6
SPECIAL STUDIES

6.1 REVEGETATION

RBOSC continues to revegetate and/or temporarily stabilize disturbed areas. During the reporting period, approximately 13 acres were seeded with a combination of winter and annual rye grass. The rye grass will serve as a stubble mulch into which the appropriate seed mix will be drilled during fall revegetation efforts. Areas seeded were primarily pipeline corridors and drill pads. In addition, road cuts along the Airplane Ridge Access Road, portions of the process area and several sections of the West Retention Pond slopes were hydroseeded and hydromulched.

6.2 SUBSIDENCE

All subsidence monuments were surveyed for vertical movement; no movement was detected. Twenty-five monuments were surveyed for horizontal movement; no movement was detected. Locations of subsidence monuments were presented in RBOSC MDP Monitoring Report 4 (Appendix 6-3.1). These locations remain the same, with the exception of monument A-2, which was destroyed by construction activities.

Elevations were obtained on the casing flanges of drill holes associated with Retort "O" prior to any blasting and after each blast. No vertical movement could be detected in any of those casings.

6.3 RUN-OF-MINE LYSIMETER

Negotiations among RBOSC and several federal agencies resulted in an agreement to conduct leaching studies on stockpiled run-of-mine ore. To fulfill our portion of the agreement, RBOSC has constructed three lysimeters in the run-of-mine stockpile. Each lysimeter consists of a 10-foot square of teflon sheeting and a series of tubes and bottles to collect the leachate. Use of teflon sheeting and containers will prevent contamination by organics, and allow for complete organic analyses. The lysimeters are positioned in the run-of-mine stockpile so that leachate will be collected at 5-, 10-, and 15-foot depths. The raw ore used in the lysimeters has been removed from Retort "O". Chemical analyses will be run on ore samples collected from the lysimeters during construction.

RBOSC will maintain the lysimeters for three years, the USGS will collect accumulated leachate, and the EPA will conduct chemical analyses of the samples. Results of those analyses will be reported in subsequent monitoring reports.

SECTION 7
ECOLOGICAL INTERACTIONS

During the reporting period, December 1979 to May 1980, two major variables, snow cover and human activity, appear to have influenced the Tract C-a ecosystem. It is not possible to identify cause-effect relationships on the basis of preliminary data collected during the winter of 1979-80 and spring 1980, although some interactions were identified that should be examined in further detail. An expanding data base and continued evaluation of events are expected to result in the identification of additional interactions. Of the variables to be discussed, one is a natural event, and one relates to tract, gas-field, and recreational development activities. They are:

- Snow cover (interaction with browse and mule deer)
- Human activity on or adjacent to tract

Without question, the ecosystems were subjected to more influences than the two just identified. These two factors have been singled out because they appear to be most closely related to identified changes and can be discussed with more confidence than can other factors.

The discussion provided herein is based on an incomplete data set for 1980. Several studies are to be completed in the summer-fall season which will generate a more complete data set. A more detailed discussion of ecological interactions will be provided annually in the year-end report.

7.1 SNOW COVER

The ecological interaction examined here is the three-way relationship of snow cover, browse, and mule deer. It is the result of the heuristic examination of data collected on Tract C-a since 1978 for these programs.

The 1978-79 winter season was characterized by early snowfall, continued accumulation throughout the winter, and a late snow-melt. The snow cover was continuous throughout most of the period from November 1978 to April 1979, with a maximum measured depth of 24 inches on and adjacent to Tract C-a. The snow cover and other winter conditions resulted in mortality for a rather high percentage of the mule deer herd that winter in this area. It is speculated that most of the mortality occurred in the younger, smaller mule deer that should be considered part of a future breeding population. Results of the 1979-80 pellet survey indicated a decrease in the population from 43.1 in 1978-79 to 24.9 mule deer/sq. mile.

The winter of 1979-80 was relatively mild compared to that of 1978-79. The snow cover during the period November 1979 to April 1980, with a maximum depth of 10 inches, was not as continuous as that of 1978-79. Because the snow cover was less than that of previous winters, the deer should have been able to remain at elevations representative of Tract C-a throughout most of the winter. Therefore, the reduction noted in the mule deer population during the 1979-80 pellet survey is probably a result of the severe mortality that occurred in 1978-1979.

Average browse has decreased since 1978 in a fashion similar to that of the mule deer population on and near Tract C-a. RBOSC browse studies indicate that average utilization decreased from 21 percent in 1978, for all three vegetation types sampled, to 9 percent in 1979. It is speculated that a majority of the reduced browse utilization in 1979 was related to inability of the mule deer to migrate into the area and feed because of increased snow depth. Snow cover probably restricted deer movement to the ridge tops, south facing slopes, and valley bottoms adjacent to these slopes, where wind and solar radiation would help minimize the accumulation of snow, and make the vegetation available for deer use.

Browse utilization was even lower in 1980, in spite of the fact that the winter of 1979-80 was relatively mild and the vegetation was accessible for use by the mule deer. It is not totally clear why browse use decreased this past winter relative to 1978-79. Several points may have influenced the browse utilization.

Snow depths during 1979-80 were lower and mule deer migratory movement was probably not as restricted as in the winter of 1978-79. During the 1979-80 winter, the RBOSC wildlife biologist noted that the mule deer appeared to remain on the "normal" winter range, which includes our study areas. Consequently, browse utilization should have increased relative to 1978-79 because the mule deer remained on or near the study site.

On the other hand, browse utilization may be related more to the size of the mule deer herd than to the actual time spent on the winter range. The size of the mule deer herd was much smaller than the previous winter, as noted earlier in this section. This seems to indicate that the deer herd size (i.e. number of deer per square mile) may be a driving variable in the amount of browse utilized on and near Tract C-a. If this is the case, then reduced browse use is dependent more on herd size than on winter range as controlled by snow depth.

Without question, this three-way ecological interaction is an over-simplification of the conditions described and other, more descrete, variables also influence the system. Continued monitoring over an extended time frame will provide us with the data needed to help refine and/or confirm these interactions and influences of snow cover, browse utilization, and the mule deer population on Tract C-a.

7.2 HUMAN ACTIVITY ON OR ADJACENT TO TRACT C-a

Oil shale development and natural gas exploration on and near the tract has resulted in increased activity. Increased road traffic has resulted in wildlife losses along many roads in the area. The RBOSC mule deer road kill survey indicated that 11 mule deer were involved in automobile/mule deer collisions along County Road 24 between December 79 and April 80. These wildlife losses are small when compared to the natural winter mortality that has resulted in 42.2% reduction in the mule deer herd between the winter of 78-79 and the winter of 79-80.

The heavy traffic along County Road 24 into Tract C-a did not adversely affect the nesting activity of a pair of golen eagles which successfully hatched an eaglet in a nest immediately adjacent to the road in mid April of 1980.

Increased activities in the Piceance Basin by oil shale and natural gas developers, along with population expansion and improved accessability to state and federal recreational use areas, may have some potential effects on the area. These potential effects on the Tract C-a area will be evaluated and studied as more data become available.

SECTION 8
SUMMARY

Air quality and meteorological data were collected during the six-month reporting period. No unusual events or violations of National Ambient Air Quality Standards occurred. All of the air quality parameters were below the threshold of detection most of the time, with the exception of ozone and particulates. Ozone concentrations ranged from 0.013 to 0.077 ppm at Site 1, and from 0.003 to 0.070 ppm at Site 3. Particulate concentrations ranged from 1 to 42 $\mu g/m^3$ at the two sites measuring the ambient particulate levels (Sites 1 and 2) and from 1 to 51 $\mu g/m^3$ at the site located in Corral Gulch (Site 3), which is often downwind of tract activities. These values are similar to those found in earlier mid-year reports (MDP Monitoring Reports 2 and 4).

No significant changes have been detected in the meteorological data collected during the six-month data period.

A Spring visibility study using both the traditional photometric method and a telephotometer to measure visual range has been initiated but was not completed during this reporting period. The results of the Spring study will be reported in the year-end report, along with the results of the Fall study.

Two noise surveys were taken during the reporting period. During the February survey, sound level averages on the tract ranged from 22 to 40 dBA, except near the main construction area (adjacent to headframe), which averaged 76 dBA. During the May survey, sound level averages ranged from 33 to 49 dBA, except for an average of 77 dBA near the main construction area.

The components of the MDP Terrestrial Monitoring Program examined during the reporting period were browse condition and utilization, mule deer density, mule deer road kills, and feral horse abundance.

Browse studies indicate that the weighted average percent utilization ranged from 1 percent in the upland sagebrush to 10 percent in the pinyon-juniper vegetation type. Utilization in all vegetation types decreased relative to 1979 data and is the lowest recorded in five years of study. Lower use in 1980 relative to 1979 may be due to decreases in mule deer herd sizes between the two years. The smaller mule deer population combined with the relatively

harsh 1978-79 winter season have resulted in the continued decline in browse use since May 1978.

Range condition ratings based on age class and/or hedging class were similar to those evidenced during 1979; however, there is some indication that range condition is improving. Improvements are evident primarily in ratings based on hedging classification, and are probably due to lower browse utilization. Because the RBOSC browse studies are designed to census the same individuals on a yearly basis, one would not expect to find large changes in range condition ratings based on age classification.

The average number of mule deer per square mile using the Tract C-a study area during the winter of 1979-80 24.9, was approximately 65 percent of the number using that area during the 1978-79 winter. This reduction in mule deer density is probably a result of the extensive winter kill during 1978-79.

The number of mule deer killed by vehicle collisions along Rio Blanco County Road 24 during the reporting period was 11. Nine deer killed by collisions with vehicles were found there during the same period the year previous. The paving of the county road during the interim and increased traffic may account for the additional deer kill.

A total of 120 feral horses in 24 bands was counted in the study area during the winter aerial The count was up from 99 horses observed during the 1979 aerial survey.

The data for the physical parameters measured at each aquatic sampling station varied appreciably from year to year. Measurements for April 1980 fell within the range of the previous years, and no large fluctuations were demonstrated by a comparison of the physical and chemical data obtained in May 1979 and May 1980.

The data for the water quality parameters measured in the White River (Stations 27 and 29) changed very little from baseline conditions. However, increased levels of silica and sulfate occurred at both stations during April and May

1980. The amounts are close to the baseline mean for these parameters. No major differences were found between the water quality data obtained above and below the confluence with Yellow Creek.

April 1980 total mean periphyton densities varied from 1,789 units/mm^2 at Station 27 in the White River to 349 units/mm^2 at Station 13 in Corral Gulch. Total mean periphyton densities in Corral Gulch (Stations 13 and 14) were lower than the values from April samples of previous years. Total mean periphyton densities in Yellow Creek (Stations 20 and 21) and the White River (Stations 27 and 29) were higher than the ones from April 1979 but lower than the densities of previous years.

The total mean periphyton densities in May 1980 varied from 8,677 units/mm^2 at Station 14 in Corral Gulch to 118 units/mm^2 at Station 29 in the White River. Station 13 in Corral Gulch and Station 20 in Yellow Creek had lower mean periphyton densities in May 1980 than in May 1979, while Station 14 in Corral Gulch and Station 21 in Yellow Creek had higher values. The White River (Stations 27 and 29) was not sampled in May 1979. A similar relationship between total mean periphyton densities occurred between April and May 1980. Stations 27 and 29 had higher periphyton densities in the former month than in the latter.

May 1980 biomass values were generally lower than the numbers for April 1980 and May 1979. The biomass values for April 1980 were generally higher than the April 1979 numbers. No trends were readily apparent when compared to previous biomass data for April. However, the White River station downstream from the confluence with Yellow Creek (Station 29) usually had lower biomass values than the upstream station (Station 21).

In summary, periphyton densities were generally lower at sampling stations during April 1980 than in April samples of previous years. The only discernible trend in April periphyton biomass data occurred in the White River where biomass and density appeared to be lower below than above the confluence with Yellow Creek. May sampling was initiated in 1979. When comparing the May 1979 and May 1980 biomass and density values, no trends are apparent.

The macroinvertebrate taxonomic diversity remained low at Corral Gulch (Stations 13 and 14) and Yellow Creek (Stations 20 and 21). The fauna reflects the relatively harsh environment subject to irregular perturbations common to small streams in the Piceance Basin. An abundant and diverse riverine fauna exists at Stations 27 and 29 in the White River, and there was no evidence of any adverse effects upon the macroinvertebrate fauna at the sites sampled below the Yellow Creek confluence.

The hydrology program provides data necessary to satisfy lease stipulations and conditions of approval from the AOSO; assess impacts of dewatering and reinjection (development activities); provide input to engineering design of the mine and water handling system; supply information necessary for environmental disciplines to determine if mitigative measures are necessary; and collect data for compliance with permit stipulations. Data collected between December 1979 and May 1980 were compared with data collected during baseline studies initiated in July 1974. Stream gaging and erosion stations, springs and seeps, alluvial and deep aquifer holes, surface water impoundment, discharges, and reinjection and dewatering wells were monitored.

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- Upper and Lower Aquifer Water - Natural recharge occurred in the west and northwest portions of the tract. Reinjection was reinitiated in the northwest corner of the tract during the reporting period.

- Development Activities - Two new dewatering wells were completed which increased the total water production about 400 gpm.

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